# REPORT DOCUMENTATION PAGE

*Form Approved*
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| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | 28 Aug 95 | |

**4. TITLE AND SUBTITLE**
Horizontal Team Member Exchange (HMX): How Team Member Relationships Affect Individual and Team Outcomes

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**
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**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**
Michigan State University

**8. PERFORMING ORGANIZATION REPORT NUMBER**
96-024D

**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**
DEPARTMENT OF THE AIR FORCE
AFIT/CI
2950 P STEET, BLDG 125
WRIGHT-PATTERSON AFB OH 45433-7765

**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**



**11. SUPPLEMENTARY NOTES**

**12a. DISTRIBUTION / AVAILABILITY STATEMENT**
Unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** *(Maximum 200 words)*

**14. SUBJECT TERMS**

**15. NUMBER OF PAGES**
185

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
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| | | | |

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# HORIZONTAL TEAM MEMBER EXCHANGE (HMX): HOW TEAM MEMBER RELATIONSHIPS AFFECT INDIVIDUAL AND TEAM OUTCOMES

By

Earl Ray Nason

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Psychology

1995

28 August 1995

FROM: HQ USAFA\DFBL (Capt Nason)

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Earl R. Nason

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Instructor
Department of Behavioral Sciences and Leadership

1 Atch
Dissertation

## Horizontal Team Member Exchange (HMX):
## How Team Member Relationships Affect Individual and Team Outcomes

### Introduction

Teams build our automobiles (Sherman, 1994), manage our companies (Hackman, 1990), protect our country (Oser, McCallum, Salas, & Morgan, 1989), and are increasingly employed in the U.S. workplace (Ilgen, Major, Hollenbeck, & Sego, 1995) to accomplish complex and critical tasks (Kozlowski, Gully, McHugh, Salas, & Cannon-Bowers, in press). Perhaps the single feature which most distinguishes teams from other organizational forms is that team members are interdependent; they must interact to accomplish their work (Dyer, 1984). Although some proclaim the benefits of teamwork without caveat (e.g., Teampower, 1994), team member interactions can be the source of process losses (Steiner, 1972) as well as synergistic performance gains (Hackman, 1987). One approach to understanding team member interactions is to focus on dyadic working relationships; to seek to understand how they develop (e.g., Gabarro, 1990) and how they influence the way team members interact.

Although role theory (e.g., Katz & Kahn, 1978) and its derivatives, leader-member exchange (LMX; e.g., Graen & Scandura, 1987) and team-member exchange (TMX; Seers, 1989) provide a framework for understanding workplace interactions, they do not address the working relationships in team dyads. Role theory describes the interactions in social systems in general but provides no specific guidance for team dyads. LMX focuses on the leader-subordinate dyad and is concerned solely with the quality of the vertical exchange relationship; it acknowledges, but does not address, the impact of horizontal relationships. TMX focuses on the relationship between a single member and the entire peer group, ignoring the dyadic interactions between team members.

Furthermore, several aspects of LMX and TMX make their direct generalization to horizontal exchange relationships among team members inappropriate. First, there is a mismatch between theory and practice in LMX and TMX as to the level of their focal

construct. Second, neither perspective accounts for the characteristics (e.g., differentiated roles and interdependence) which differentiate teams from other organizational forms. Finally, although TMX focuses on team members; it ignores the within-group variations in horizontal dyadic relationships.

Similarly, none of the recent theoretical perspectives on teams focuses directly on the interactions among team members. For example, Ginnett's (Hughes, Ginnett, & Curphy, 1993) team effectiveness model includes a group dynamics factor but the model is so broad, little is gained by acknowledging the importance of team member relations. The theory of team development proposed by Kozlowski, Gully, Nason, Ford, Smith, Smith, and Futch (1994) recognizes the importance of vertical and horizontal relationships in teams but concentrates on the developmental changes maturing teams experience rather than on how dyadic relationships can impact team performance. Similarly, Ilgen and Hollenbeck's team decision making theory focuses on leaders and member decision making interactions rather than on how horizontal relationships can affect team decisions (Ilgen et al., 1995). Thus, recent perspectives have not explored the unique dyadic relationships among team members or the effects they may have.

The limitations of existing theoretical perspectives indicate the need for work which illuminates how the interactions among team members affect individual and team outcomes. This paper explores the effects of dyadic horizontal exchange relationships (HMX) in teams. To that end, several literatures (e.g., role theory, LMX, and TMX) are reviewed and integrated to build a conceptual model which depicts the central role of HMX in teams. The results of a study which explored the effects of perceived similarity and team members' expectations for others on HMX and team processes and performance are reported, including several key outcomes in the HMX model (i.e., individual performance and attitudes as well as team performance). The following review of literature from role theory, LMX, and TMX provide a foundation for understanding team member relationships and underscore the advantages of focusing on dyad interactions.

Role Theory

Role theory explains how members of social systems define the behaviors expected of a person occupying a specific position via the role making process (Katz & Kahn, 1978). During role making, organizational members communicate their expectations for a position and negotiate acceptable behaviors with the person occupying the position (Graen & Scandura, 1987). Members engage in a cycle of sending, receiving, interpreting, and responding to behavioral expectations. Over repeated interactions, the set of behaviors associated with a position is refined as members come to understand each others' expectations. Over time, dyad members fall into a regular, predictable pattern of interaction. The result is a role, which is defined by the set of behaviors expected of an organizational member in a specific position.

Since role making requires negotiation, it can only occur in situations in which formal job definitions are incomplete and there is some flexibility or ambiguity in the behavior associated with a position (Dienesch & Liden, 1986). This situational ambiguity has also been couched in terms of task structure. Thus, according to Graen and Scandura (1987), role making is a theory of role emergence which describes "how the behavior of individual participants becomes integrated with others into coordinated and interdependent teamwork for accomplishing unstructured tasks" (p. 176). When tasks are completely unstructured, role making negotiations must be based solely on personal expectations.

In work organizations, role expectations are usually partially defined by job descriptions. However, organizational roles typically include formal job descriptions as well as informal expectations (Ilgen & Hollenbeck, 1990). In fact, it is the combination of the personal and formally defined expectations which link organization members together by virtue of their interdependence requirements. Katz and Kahn (1978), for example, believed organizations can best be understood as role systems, that is, recurrent behavioral patterns exhibited by members enacting interlocked roles.

Although Katz and Kahn (1978) discussed role systems in terms of entire organizations, these same principles apply to teams. That is, teams can be best understood in terms of the recurrent patterns of interaction among team members enacting interlocked roles. In this respect, role theory recognizes the importance of team member interactions and relationships. However, role theory does not the nature of the interlocked roles of team members. While several types of interlocked team roles exist (e.g., leader-member, leader-subordinate group, member-member, member-peer group), the leader-subordinate relationship has probably received the most attention.

Leader-Member Exchange Theory

Organizational newcomers learn what is expected of them from many sources (Ostroff & Kozlowski, 1992). However, leaders provide one important source by which new members learn their role (Dienesch & Liden, 1986; Kozlowski et al., 1994). Leader-member exchange is a leadership theory which elaborates and applies role theory to the unique, vertical dyadic relationships which form between leaders and their followers. LMX describes the interaction process by which subordinates negotiate roles with their leaders as well as the antecedents and the effects of the quality of the vertical dyadic working relationships established through that process.

Within the LMX framework, the relationship between leaders and their subordinates is based on the exchange of resources; leaders trade the positional resources available to them in exchange for desired role behavior from their subordinates (Dienesch & Liden, 1986). Leaders may offer many different resources for exchange, including information, influence, task assignments, latitude, support, and attention in return for the subordinate's compliant role behavior and loyalty (Graen & Scandura, 1987). In the course of the exchange process, leaders establish a unique relationship with each subordinate, rewarding some, while virtually ignoring others (Dansereau, Graen, & Haga, 1975). This unique, vertical relationship between leader and follower forms very early in the life of the dyad (Dockery & Steiner, 1990) and is stable over time (Graen & Cashman,

1975; Graen, Cashman, Ginsburg, & Schiemann, 1977). By emphasizing the uniqueness of the vertical relationships within a unit, LMX recognizes the importance of the within-group variations in superior-subordinate relationships. Recognition of the within-group variation in leader-follower relations distinguishes LMX from earlier average leadership style theories, which assumed, in theory and method, that leaders treat all their subordinates equally (Dienesch & Liden, 1986; Graen & Scandura, 1987).

Graen (1976) suggested that time pressure (i.e., the inability of the leader to perform all the tasks required to make the unit function smoothly) is the force which drives leaders to differentiate among their subordinates. Time pressure forces leaders to look to their subordinates for assistance. Leaders categorize their followers as either in-group or out-group members in an effort to maximize unit performance. Leaders choose as in-group members those subordinates they believe have greater competence and skill, are more trustworthy, and are motivated to assume greater responsibility (Liden & Graen, 1980). In-group members are asked to assist the leader by performing the important duties the leader does not have time to perform but out-group members are asked to perform only the tasks officially assigned to them by the organization. The consequences of this process of differentiation extend far beyond the assignment of work tasks.

Leader-members exchange relationships differ substantially for in- and out-group members. For example, Dansereau et al. (1975) distinguished in- and out-group exchange relationships based on how leaders behaved toward their subordinates. They found that supervisors employed leadership techniques (influence without the use of authority) with in-group members but used supervisory techniques (influence based only on authority) with out-group members. With in-group members, leaders used their working relationship as a lever to exert influence without the use of authority. The same leaders employed only authority-based (supervisory) techniques with out-group members. Out-group subordinates were expected to perform their officially assigned duties in return for their pay; nothing more or less was expected of them.

Many other aspects of the vertical working relationship also varies according to in- and out-group status. For example, in-group exchange relationships are characterized by greater trust, respect, loyalty, liking, intimacy, support, openness, and honesty relative to out-group relationships (Graen & Scandura, 1987). These differences have led some to describe in-group and out-group relationships as mentor-protégé versus overseer-peon (Graen & Scandura, 1987) or cadre versus hired hand (Schriesheim, Neider, Scandura, & Tepper, 1992).

In an elaboration of Katz and Kahn's (1978) description of role cycles, Graen and Scandura (1987) proposed a descriptive, developmental model of role making. The model depicts leader-member relationships as progressing through three stages: role taking, role making, and role routinization. In the first stage, the subordinate is passive, while the leader learns about the subordinate. In this stage, the leader controls the relationship. In the role making phase, the leader and follower exchange their expectations for role behavior but the leader continues to dominate the exchange process. During role routinization, leader-member interactions become predictable and form "orderly sequences of reciprocal behavior" (Graen & Scandura, 1987, p. 184). In Graen and Scandura's (1987) model , the vertical relationship develops over an unspecified amount of time, however, the empirical evidence discussed below suggests the initial categorization process can occur very quickly and in- versus out-group decisions may even be made before the leader and subordinate meet.

LMX theory emphasizes the taking of an organizational role by a subordinate from a superior, especially in the initial stages of an exchange relationship (Graen & Scandura, 1987). For example, superiors provide in-group members with more challenging assignments, more opportunities to learn, and the chance to perform important tasks (Liden, Wayne, & Stilwell, 1993). Leaders also provide more support to in-group members and protect them from outside forces (Dansereau et al., 1975). In the later stages of exchange relationships (i.e., role making and routinization), subordinates,

especially in-group members, may help shape their role. However, LMX theory and empirical research have tended to minimize subordinates' contributions to the exchange relationship even during the role making phase.

The asymmetries in vertical working relationships are based on the power and resource differentials which exist between leaders and subordinates. In teams, however, the differences in power and resources are likely to be smaller or nonexistent among peers (Seers, 1989). Therefor, the horizontal exchange relationships among team members are not likely to be as one-sided. Two consequences result form the symmetry in team member relationships. First, the exchange process among team members should be more balanced because similar resources are available for exchange. In addition, the role making process among team members is not likely to exhibit a role taking phase. Occasionally, larger status differences may exist, such as when new members are integrated into an existing team. In these cases, the exchange process may more closely resemble a vertical rather than horizontal relationship.

The central construct in LMX theory is exchange relationship quality. Relationship quality has been described as the effectiveness of the dyadic working relationship between leader and member and is often referred to as simply LMX. (Graen & Scandura, 1987). Operational definitions of LMX have included the degree of negotiating latitude the leader provides the subordinate (Dansereau et al., 1975; Liden & Graen, 1980), relationship quality (Deluga & Perry, 1991; Dockery & Steiner, 1990), the quality of information exchange (Kozlowski & Doherty, 1989), and sociometric nominations of the best and worst working relationships in a unit (Duchon, Green, & Taber, 1986). Although exchange relationships have been shown to differ in a number of ways (e.g., trust, respect, loyalty, liking, intimacy, support, openness, and honesty; Graen & Scandura, 1987), LMX has, almost exclusively, been discussed and operationalized as a unidimensional construct with several aspects. Others, however, have questioned the dimensionality of LMX.

Dienesch and Liden (1986), for example, identified the question of the dimensionality of the relationship quality construct as a critical theoretical and operational issue for LMX. Assuming the dimensions of the LMX construct must be mutually valued and available for exchange to both leaders and members, Dienesch and Liden (1986) concluded LMX is probably three dimensional. They identified performance, loyalty, and affect as three dimensions which meet these requirements (i.e., they are mutually valued and available for exchange to both dyad members). The authors defined performance or perceived contribution to the exchange as "perception of the amount, direction, and quality of work-oriented activity each member puts forth toward the mutual goals (explicit or implicit) of the dyad" (p. 624). The loyalty dimension consists of "the expression of public support for the goals and the personal character of the other member of the dyad" (p. 625). They defined the affective component as "the mutual affection members of the dyad have for each other based primarily on interpersonal attraction rather than on work or professional values" (p. 625).

In an attempt to distinguish LMX from the satisfaction with another, Graen and Scandura (1987) argued against the inclusion of affective items in LMX measures. Citing a study by Graen, Liden and Hoel (1982), they claimed items assessing liking or satisfaction with supervision decreased the validity of the construct. However, the only evidence the Graen et al. (1982) article provided concerning the discriminant validity of LMX and affect was that the correlation between LMX and turnover decreased after partialling satisfaction with supervision. Contrary to Graen and Scandura's (1987) argument, this result indicates LMX and affect share variance with turnover, not that affect should be excluded as a component of LMX. Scandura has, apparently, reversed his position and has since published research employing an LMX scale which includes affective items (i.e., Schriesheim, Neider et al., 1992; Schriesheim, Scandura, Eisenbach, & Neider, 1992). In this research, an LMX scale including affective items was reliable and related to, but distinguishable from, measures of satisfaction.

In an exception to the unidimensional treatment of relationship quality, the study by Schriesheim, Neider et al., 1992) supported a three dimensional structure conforming to the performance, affect, and loyalty dimensions suggested by Dienesch and Liden (1986). However, in their follow-on paper (Schriesheim, Scandura et al., 1992), the authors again treated LMX as unidimensional. The latter paper assessed the convergent and divergent validity of a unidimensional LMX construct, using the LMX-6 scale, and found strong support for their approach. Schriesheim and colleagues (Schriesheim, Neider et al., 1992; Schriesheim, Scandura et al., 1992) found the LMX-6 scale had acceptable internal consistency (Cronbach's alpha = 0.79 - 0.84) and test-retest reliability ($r$ =.77 at two weeks and $r$ = .82 at 1 week). The LMX-6 measure also had high convergent validity ($r$ = .82; .94 corrected for unreliability) with the frequently used LMX-VII measure (Scandura & Graen, 1984). Thus, although the dimensionality of LMX remains unclear, the construct is typically treated as unidimensional.

Researchers have successfully predicted a number of individual and organizationally relevant outcomes with exchange relationship quality. For example, researchers have found relationships between LMX and member satisfaction (Dansereau et al., 1975; Schriesheim, Neider et al., 1992; Seer, 1989), organizational commitment (Duchon et al., 1986), job performance (Dunegon, Duchon, & Uhl-Bien, 1992; Schriesheim, Neider et al., 1992; Seers, 1989), and turnover (Ferris, 1985; Wilhelm, Herd, & Steiner, 1993).

In addition, much has been learned about the antecedents of vertical exchange relationship quality. Ingratiation tactics (Deluga & Perry, 1991; Dockery & Steiner, 1990; Wayne & Ferris, 1993), perceived similarity (Liden et al., 1993), liking (Dockery & Steiner, 1990; Liden, Wayne, & Stilwell, 1993; Wayne & Ferris, 1993), and performance (Deluga & Perry, 1994; Liden et al., 1993) have all been found to affect relationship quality. In addition, both affect (leader liking of member and vice versa) and leader and

member perceptions of member performance are important to the formation of high quality vertical relationships (Dockery & Steiner, 1990; Liden et al., 1993).

The studies cited above demonstrate the extensive nomological network of antecedents and consequents within which relationship quality resides. For the most part, however, these studies are correlational rather than experimental. Because they are correlational, they do not insure the phenomenon observed are amenable to intervention. However, some research has manipulated relationship quality and demonstrated that practical interventions based on LMX theory can be implemented in organizational settings. For example, training leaders to raise the quality of their working relationships proved to be an inexpensive and effective method of improving organizational outcomes (e.g., Graen, Novak, & Sommerkamp, 1982; Scandura & Graen, 1984).

On the whole, it appears vertical relationship quality is an important phenomenon in organizations. It is a reasonably reliable, valid, and practical construct. A more extensive review of the LMX literature will describe several main thrusts of LMX research as well as elaborate relationship quality's causal net.

Early work. Early LMX research focused on demonstrating the existence of unique relationships between leaders and their subordinates. Negotiating latitude, an early version of the relationship quality construct, indexed the degree to which a supervisor allowed subordinates to participate in role definition. Dansereau et al. (1975) divided subordinates into in- and out-groups (those in the upper half of the distribution of negotiating latitude scores were designated as in-group members) based on negotiating latitude scores measured two months after dyad formation. The authors cited the fact that 85% of leaders supervised members in both the upper and lower score ranges as evidence that leaders and members do form unique relationships. Similarly, after trichotomizing negotiating latitude scores, Liden and Graen (1980) found over 90% of the units they studied contained both in- and out-group members (the upper and lower thirds).

Dansereau et al. (1975) used in- and out-group membership to predict the effects of negotiating latitude on leader behavior, member behavior, and member satisfaction at seven and nine months. Several important outcomes were associated with the amount of negotiating latitude. In-group members reported receiving more attention and support from their leader than did out-group members. In-group members also reported their leader caused them fewer problems and were more sensitive to their job needs than did out-group members. In-group members reported they performed more varied role behaviors and more supervisory-like behaviors, such as administering and communicating. In-group members performed role behaviors which were more consonant with their own desires and their leader's preferences than out-group members. Finally, in-group members were more satisfied with the job than out-group members. These studies demonstrated that leaders do, in fact, form differentiated relationships with their subordinates and that these relationships are associated with several outcomes relevant to individual organizational members.

Demonstrating the within group approach to leadership. A second thrust of LMX research was to demonstrate the dyadic approach to leadership was more predictive of organizational outcomes than average leadership approaches, which took a "between groups" approach. In the average leadership approach (e.g., Leader Behavior Description Questionnaire; Fleishman & Hunt, 1973), responses from members within a unit are averaged to create a single description of leader behavior. This approach assumes within unit variations in member perceptions of leader behavior are error variance and all meaningful variation in leader behavior occurs between groups. To demonstrate the advantage of the dyadic approach, some LMX researchers subtracted the unit average from members' relationship quality scores to isolate within group variance. Using this method, Graen et al. (1982) demonstrated within group variance in member perceptions of vertical dyad relationship quality was a better predictor of turnover than between group

variance. Ferris (1985) also showed within group variance on relationship quality was a better predictor of turnover than either between group variance or employee attitudes.

However, the use of within group relationship quality scores was not always found to be the better approach. Vecchio (1985) found neither between nor within group relationship quality variance predicted turnover. Using hierarchical regression procedures, Vecchio and Gobdel (1984) showed within group variance accounted for no additional variance in performance ratings after accounting for between group variance. Perhaps because within group variance does not always exceed between group variance, later LMX researchers have abandoned the "within group only" approach, apparently concluding that using the total variance in relationship quality scores is more useful than using only within- or between-group variance. While this is hardly a surprising conclusion, the research thrust provided further support for LMX as a useful approach to the study of within-unit leadership phenomena.

The effects of vertical relationship quality. A third research thrust has attempted to place LMX within a nomological network of antecedents and consequents. The following section describes research on the effects of relationship quality. Research on the causes of LMX will be reviewed in a later section.

As one might expect, members in high quality working relationships are also more satisfied. The relationship between LMX and affect extends to several facets of satisfaction. Several studies (e.g., Dansereau et al., 1975; Graen et al., 1982; Scandura & Graen, 1984) have found relationships between LMX and satisfaction using the Hoppock Job Satisfaction Blank (Hoppock, 1935) as a measure of overall job satisfaction. In several other studies, relationship quality predicted satisfaction with supervision (Graen et al., 1982; Stepina, Perrewe, Hassell, Harris, & Mayfield, 1991; Vecchio & Gobdel, 1984) as measured by the Job Descriptive Survey (Hackman & Oldham, 1975). LMX quality is also related to subordinate satisfaction with the technical competence of the supervisor (Graen et al., 1977). The correlations between relationship quality and the various facets

of satisfaction have generally been strong. Correlations between LMX and items from the long form of the Minnesota Satisfaction Questionnaire have ranged from $r = .63$ to $r = .71$ (Schriesheim, Neider et al., 1992; Schriesheim, Scandura et al., 1992). Although a few studies have failed to find a relationship between LMX and satisfaction (e.g., Liden & Graen, 1980; Seers & Graen, 1984), the weight of evidence suggests exchange relationship quality has a strong impact on satisfaction.

The relationship between LMX and performance has also been of great interest to organizational researchers. In one field experiment, Graen et al. (1982) were able to increase objective measures of member productivity by providing relationship training to leaders. In another field experiment, when leaders provided growth opportunities (i.e., the kinds of opportunities typically extended only to in-group members) to high growth need strength members, production quantity increased by 55%, while quality was maintained or improved (Graen, Scandura, & Graen, 1986). As expected, members with low growth need strength did not increase productivity even when given the opportunity to collaborate with their leader. Similarly, using a training intervention like the program used by Graen et al. (1982), Scandura and Graen (1984) were able to increase both productivity (average output over 10 weeks) and rated performance. An important finding of this study was that the intervention used was most effective for members who began the experiment with a low quality relationship with their leader. Apparently, interventions to increase LMX can be effective and are most effective for those who can most benefit from them.

Other studies have related LMX to performance ratings. Liden and Graen (1980) found a positive relationship between LMX and rated performance. Rosse and Kraut (1983) found significant correlations between rated performance and negotiating latitude as reported by the member ($r = .13$) and the leader ($r = .20$). Schriesheim, Neider et al. (1992) reported a moderately strong correlation ($r = .40$) between relationship quality and rated performance. Vecchio and Gobdel (1984) found a positive relationship between LMX and rated performance.

One interpretation of the relationship between LMX and performance ratings is that actual performance and relationship quality combine to influence performance ratings. For example, Duarte, Goodson, and Klich (1993) found a significant relationship between LMX and overall rated performance ($r$ = .23) and two composite ratings of task ($r$ = .26) and relationship ($r$ = .30) performance. Hierarchical regression analyses showed objective performance and LMX interacted to determine rated performance, such that high quality LMX members were given high performance ratings regardless of their objective performance levels. Members with low quality relationships with their leader were given high performance ratings only if their objective performance was also high.

In a replication and extension of their previous work, Duarte, Goodson, and Klich (1994) found a three way interaction between objective performance, relationship quality, and relationship duration. Performance ratings for short term relationships (2 months) conformed to the findings above (i.e., ratings commensurate with objective performance for low quality members but high ratings regardless of performance for high quality members). Over longer terms (34 months), all members received relatively high performance ratings, regardless of objective performance measures. This result is difficult to interpret as it may have resulted from the characteristics of the rating system (e.g., leniency and ceiling effects) rather than an interactive relationship with LMX quality. Dunegan et al. (1992) also found a positive relationship between LMX and rated performance. However, they found the nature of the task affected the relationship. LMX and rated performance were only related when tasks were either highly challenging (low analyzability and high variety) or not challenging at all. LMX and rated performance were not related when tasks were moderately challenging.

Although a few studies have found no relationship between LMX, rated performance (Graen et al., 1982; Stepina et al., 1991; Wayne & Ferris, 1990), and objective performance measures (Duarte et al., 1993; Vecchio & Gobdel, 1984), the findings generally indicate LMX and performance are related and that rated performance

has a stronger relationship with LMX than does objective performance. However, the causal sequence and processes which relate relationship quality and performance are not as clear.

The stronger relationship of LMX to rated performance relative to objective performance might indicate supervisors are biased towards those with whom they have high quality relationships and give some in-group members performance ratings they do not deserve. Alternately, the rewards offered to in-group members may facilitate their better performance. That is, one would expect in-group members, who have more information, influence, task assignments, and latitude, to perform better. A third possibility is that in-group members become motivated to higher performance because of the attention lavished on them by their supervisor.

Similar concerns about the link between LMX and performance exist for the Pygmalion effect (e.g., Sutton & Woodman, 1989). For the Pygmalion effect, the interactions in vertical exchange relationships have been described as the mechanism by which expectations influence performance (Eden, 1990). Because LMX provides a more comprehensive view of the exchange process (i.e., LMX combines performance expectations, affect, and trust elements), the Pygmalion effect will be considered to be an aspect of relationship quality and will be discussed in a later section concerning the effects of performance expectations on relationship quality.

Relationships between LMX and several other outcomes, such as performance attributions and organizational citizenship behaviors (OCBs), have also been found. For example, leaders make performance attributions which are consistent with their subordinates' in-group or out-group status. Heneman, Greenberger, & Anonyuo (1989) found leaders were more likely to interpret the high performance of in-group members as resulting from internal factors, such as ability, relative to out-group members. Alternately, leaders were more likely to attribute the ineffective performance of out-group members to internal factors. Based on the reasoning that trust is a component of exchange relationship

quality, Konovsky and Pugh (1994) tested a model wherein relationship quality mediated between justice perceptions and OCBs. They found good fit for a structural model in which trust mediated the relationship between justice perceptions (distributive and procedural) and OCBs. Finally, Liden and Graen (1980) found that members who had high quality relationships with their leader thought their leaders were more sensitive to their needs and were more willing to contribute extra time and effort to get the job done than were members who had low quality relationships with their leader.

The antecedents of relationship quality. Interest has also focused on the antecedents of relationship quality. Some of this work has investigated the subordinate's ability to influence relationship quality. LMX quality has been found to be related to the use of upward influence strategies (ingratiation behaviors). For example, members of high quality relationships tend to use supervisor focused ingratiation tactics (e.g., opinion conformity) more often than those with low quality relationships (Deluga & Perry, 1991; Dockery & Steiner, 1990; Wayne & Ferris, 1990). On the other hand, out-group members claim they use assertive behaviors, coalitions, and appeals to higher authority to obtain desired behaviors from their leader more often than in-group members (Deluga & Perry, 1991). In-group members also believe their influence attempts are more successful and that their leaders are more effective (Deluga & Perry, 1991). In addition, supervisors' perceptions of their subordinate's use of other enhancement behaviors predicted relationship quality after controlling for the effects of supervisor performance ratings. Thus, relationship quality is sensitive to the influence attempts of dyad participants, in- and out-group members appear to use different ingratiation techniques, and the influence of ingratiation tactics on LMX appears to be separable from the impact of prior job performance.

In addition to the influence of ingratiation tactics, relationship quality has also been shown to be sensitive to dyad members' perceptions. For example, in a laboratory study which investigated the initial interactions between member and leader, Dockery and

Steiner (1990) showed leader and member perceptions of member ability and liking were related to LMX quality. One interesting finding from the study was that the leader and member perspectives differed in important ways. Members' LMX ratings were more highly correlated with the degree to which they liked their leader ($r$ = .52) than with perceptions of their own ability ($r$ = .24). However, leaders' LMX ratings were more highly correlated with their perceptions of member ability ($r$ = .85) than with their liking of the member ($r$ = .66). The results for leader perceptions seem reasonable given the instrumental nature of exchange relationships. As LMX theory predicts, leaders form higher quality relationships with subordinates whom they believe have more ability and who are more likely to make the unit successful (Dienesch & Liden, 1986). It is important to recognize that of the studies reviewed in this section, only Dockery and Steiner's (1990) results, which were based on leader perceptions, address the relative impact of affect and ability as specified by LMX theory. The results for member perceptions assess the contributions of liking versus own ability and do not conform to Dienesch and Liden's (1986) description of trust, affect, and the other member's contributions to the relationship as aspects of relationship quality.

Another issue raised by Dockery and Steiner (1990) is whether it is the actual or expected contributions to the exchange relationship which constitute the performance aspect of vertical exchange relationships. This may be solely an issue of when LMX is measured since more developed relationships allow for reciprocal effects between performance, LMX, and expectations for future performance. Because the Dockery and Steiner (1990) study manipulated perceived ability and concentrated on the initial interactions between leaders and their subordinates, it allows a clearer understanding of how performance expectations affect LMX. Because of the brief duration of the interactions involved (i.e., 10 minutes), it is unlikely that subordinates' actual performance determined relationship quality. It is more likely that leaders' performance expectations,

which were created by manipulating perceived member ability, determined the type of relationship leaders established with their subordinates.

A study by Kim and Organ (1982), which proposed noncontractual social exchange (NSE) as a continuous dimension describing leadership and supervisory behaviors, addressed the same issue. The NSE continuum can be divided into the two categories which correspond to the behaviors leaders exhibit toward in- and out-group members (Dansereau et al., 1975). High levels of noncontractual social exchange behaviors correspond to high quality exchange relationships, while contractual social exchange behaviors are reserved for out-group members. In an in-basket exercise in which subjects acted as supervisors reviewing the records of a new hiree, MBA students' beliefs about subordinate ability were manipulated by varying a memo describing the ability level of the new hirees. Perceptions of subordinate ability affected the subjects' intent to exhibit contractual or noncontractual social exchange behaviors towards their new subordinates. Subjects were more likely to establish a high quality relationship with subordinates who were described as having high ability.

These two studies (Dockery & Steiner, 1990; Kim & Organ, 1982) suggest the expectations leaders have for their subordinates' future performance affect the quality of new vertical relationships. In longer term relationships, leaders are able to assess past performance and incorporate those judgments into expectations about future performance. In the initial stages of a relationship, leaders judge expected performance based on what information is available and what they believe is relevant to the member's future performance. In either case, leaders allocate resources to those they expect will be best able to help their unit perform.

The evidence reviewed above supports the vertical dyadic leadership approach. Reliable scales for measuring LMX are available. Vertical relationship quality appears to be predictable, predictive, and practical. These qualities make the search for similar

phenomenon among team members promising. The following section presents an earlier attempt to characterize team member relationships.

Seers' TMX

Team member exchange (TMX; Seers, 1989) is a second exchange relationship concept stemming from role theory. TMX proposes that, in addition to the vertical exchanges between leaders and subordinates, team member relationships impact the role making process and affect team member outcomes. According to Seers (1989), because team members lack the positional resources which leaders exchange for expected role behavior, their dyadic relationships cannot affect role behavior and work outcomes. In effect, the dyadic exchange relationships between team member are discounted. Instead, role expectations are transmitted to team members through the relationship between a focal team member and his or her entire peer group. TMX complements LMX because the peer group influences member role behavior above and beyond the influence which results from the leader-member relationship. Seers (1989) described team-member exchange quality as follows.

> The construct of team-member exchange quality (TMX) is proposed as a way to assess the reciprocity between a member and the peer group. It should measure the member's perceptions of his or her willingness to assist other members, to share ideas and feedback and in turn, how readily information, help, and recognition are received from other members. Thus, the quality of the team-member exchange relationship indicates the effectiveness of the member's working relationship to the peer group (p. 119).

Unlike LMX, the TMX concept appears to have been studied in only two published articles. The first was the article in which Seers (1989) proposed TMX and studied the construct in 19 automotive manufacturing teams. Team members were asked to assess the quality of their relationship with their peer group by rating items, such as "Others let me know when I affect their work" and "I let others know when they affect my

work" (Seers, 1989, p. 124). Peer group members were not asked about their relationship with the focal team member.

Several significant findings emerged from Seers' (1989) study. One conclusion was that TMX showed differential validity from LMX; TMX accounted for significant proportions of variance in work, co-worker, and general satisfaction after controlling for vertical relationship quality. A second objective of the study was to determine whether TMX levels differed under different forms of organization. Because the industrial organization studied employed both individual- and team-based work settings, the author was able to distinguish their effects. As expected, workers who performed their jobs as members of teams had significantly higher levels of team member exchange quality relative to workers in the individually oriented setting. This effect was attributed to the opportunity the team-based setting provided for team members to collaborate and to the high degree of autonomy the team-based setting provided.

In addition to accounting for variance in attitudes, Seers (1989) showed the quality of the working relationship between an individual and his or her peer group accounted for variance in the individual's performance as rated by their supervisor. TMX also interacted with team members' level of motivation. Self-assessed motivation level was not associated with performance for members with high quality TMX relationships but the performance of members with low quality relationships was high only if they were highly motivated. Because these analyses did not control for the level of LMX quality, it is not clear whether TMX accounted for performance variance beyond the quality of the relationship between members and their supervisor. Finally, Seers (1989) was able to demonstrate that within-group variance in TMX quality accounted for variance in satisfaction after controlling for between group variance and that changes in TMX predicted changes in job satisfaction.

Several interesting issues arose in this initial study of TMX. First, Seers (1989) noted that peers tend to spend more time interacting among themselves than with their supervisor. Because they interact more frequently, Seers (1989) suggested that team

members may also have more influence on role behavior than supervisors and that peer influence may be especially important at the lower levels in organizations. In some cases, such as self-managed work teams, formal leaders do not exist and all interactions and role influence occurs among peers.

Most important for the purposes of the present study, despite arguing that the source of role behavior influence was the peer group (because individual team members lack positional resources), Seers (1989) concluded the dyadic level may be the appropriate focus and that personal attention and approval may provide the basis for dyadic team member influence or exchange. As discussed in later sections, although I agree with Seers (1989) that team member relationships should be assessed within the dyad, I propose that role behavior serves as the primary currency of team member exchange. Among team members who are interdependent (i.e., depend on each other), compliant role behavior is a mutually available and valued resource. In task-focused teams, personal attention and approval should flow primarily from competent performance and compliant role behavior. My position is also consistent with LMX, which asserts that subordinates exchange compliant role behavior in return for rewards from their supervisors.

Despite successfully demonstrating that peer groups influence role behavior and team member attitudes, Seers' (1989) study did not address dyadic team member exchange relationships. By doing so, TMX departs from role theory, which is based on dyadic interactions. This limitation of TMX hampers our ability to understand team member role behavior and attitudes. The following section elaborates this and other limitations which apply to both LMX and TMX theory and research. The critique also provides a basis for proposing horizontal member exchange as an important perspective for understanding how team member relationships form and the circumstances under which we should expect those relationships to affect team members.

## Limitations of the LMX and TMX Perspectives

Several characteristics of LMX and TMX limit their applicability to dyadic team member relations. Although LMX and TMX are useful in understanding certain types of organizational exchange relationships, they fail to address the dyadic relationships among team members. As a result, we know little about such dyadic relationships even though they may be of paramount importance in some instances, such as in self-managing work teams (e.g., Manz & Sims, 1987; Hackman, 1978) and in action teams in which the majority of interactions are among team members (Kozlowski et al., 1994). In fact, although Seers (1989) attributed all team member influence to the peer group, he also argued peers may have more influence on team member behavior than leaders because peers spend more time with each other than with their leader.

Dyadic Team Member Relationships

The most important limitation of LMX and TMX is that they do not address dyadic team member exchange relationships. In the former case, the limitation is intentional, LMX focuses on vertical rather than team member relationships. For TMX, however, the limitation is more troublesome for several reasons. First and foremost, after defining TMX as the relationship between a focal member and his or her peer group, Seers (1989) concluded his article by arguing it may be more appropriate to conceptualize team relationships as dyadic. He did note that dyadic assessment would be more costly and complex than member-peer group assessment. While this is a practical consideration, one should not formulate theory based on the cost of implementing research. Likewise, TMX should not be based on peer group effects solely because assessing dyadic relationships in field settings is complex. As a practical matter, the additional costs and complexity would be minimal in small teams in which the number of dyadic relationships is only slightly larger than the number of member-peer group relationships.

Second, because TMX assumes an average relationship between a focal member and his or her peers, it possesses the same limitation which LMX was designed to overcome in average leadership theories. Average leadership theories assessed leaders by

averaging subordinate responses. To take advantage of within-group variance, LMX researchers measure exchange quality from the perspective of the leader or the subordinate. However, just as happens in average leadership research, peer group perceptions, if gathered, would need to be averaged to assess the quality of a TMX relationship. Although Seers (1989) avoided averaging peer assessments by assessing TMX quality only from the focal team member's perspective, the theoretical assumption is that a single, unitary relationship exists between member and peer group. Assessing only focal member perceptions also avoids the likelihood that focal and peer perceptions differ. Thus, although TMX was defined as a member-peer group relationship, Seers (1989) provided no insight into whether peers would have provided the same assessment of a relationship as did the focal member or whether peer perceptions varied. It is difficult to consider TMX a credible complement to LMX if it does not recognize the importance of within-group variance in relationship quality as does LMX.

A third consequence of TMX's member-peer group perspective is that TMX cannot draw upon LMX's model of role development (Graen & Scandura, 1987), which is based on recurring dyadic interaction. Consequently, TMX does not and cannot describe how dyadic interactions among team members shape role formation. Although Seers (1989) provided empirical evidence for the importance of member-peer group relationship quality, TMX cannot explain how peer group influence is transmitted. If the mechanism is by dyadic interaction as role theory suggests, then team member relationships should be studied within the dyad.

Team Characteristics

Although some researchers (e.g., Seers, 1989) claim the TMX and LMX constructs are intended to apply to teams, they both ignore fundamental team characteristics. The following discussion of the characteristics of teams further illustrates why LMX and TMX cannot adequately represent team member exchange relationships.

In a review of team research and team training, Dyer (1984) defined a team as follows:

> A team consists of (a) at least two people, who (b) are working towards a common goal/objective/mission, where (c) each person has been assigned specific roles or functions to perform, and where (d) completion of the mission requires some form of dependency among the group members (p. 286).

Other researchers have used variants of this definition (Ilgen, Major, Hollenbeck, & Sego, 1995); Morgan, Glickman, Woodward, Blaiwes, & Salas, 1986; Salas, Dickenson, Converse, & Tannenbaum, 1992) but they share the following characteristics. Team members perform differentiated, interdependent roles and yet work toward a common goal. In addition, the relationships among team members are more symmetric than the vertical relationships of LMX or the member-peer group relationships of TMX. Differentiated roles, interdependence, and relationship symmetry are team characteristics which must be addressed by any team member exchange perspective.

Differentiated roles. One feature which distinguishes teams from other organizational forms is the nature of the roles team members enact. By definition, team members perform differentiated roles. Because of task driven or organizationally defined requirements, team members performing their differentiated roles will have unique expectations and requirements of each other. Thus, differentiated roles suggest the necessity for assessing dyadic team member relations. However, neither LMX nor TMX address the differentiated roles team members perform.

Dyadic interdependence in teams. In 1967, Thompson developed a scheme to describe the interdependence relationships among organizational units. In this scheme, interdependence is determined by unit task requirements. Thompson's (1967) three categories of interdependence are pooled, sequential, or reciprocal. Pooled interdependence occurs when the parts make discrete contributions to the whole. Since

no coordination between units is required, this category could be thought of as complete independence. Sequential interdependence occurs when parts make discrete contributions to the whole but those contributions occur in a fixed, serial order. According to this definition, sequential interdependence occurs units are linked such that the output for one unit becomes the input for the other. Reciprocal interdependence occurs when the parts make discrete contributions to the whole, those contributions occur in a fixed, serial order, and the output of each unit part becomes the input for the other. Under reciprocal interdependence, units exchange outputs, each providing the input for the other. Thompson (1967) described these categories as forming a Guttman scale based on increasing organizational complexity.

Van De Ven, Delbecq, and Koenig (1976) extended Thompson's (1967) definition of organizational interdependence by applying interdependence characteristics to the work performed within an organizational unit rather than between units. They defined interdependence as the degree to which individuals within a unit are dependent upon one another to perform their jobs. This definition altered the focal level of the construct by applying interdependence types to the dyads within units. The authors also described a team interdependence category representing the most complex form of interdependence, wherein work is performed collaboratively. Under conditions of team interdependence, team members work on the same portions of the task simultaneously and the which member completes a particular portion of a task is indistinguishable. The dyadic exchanges in the team interdependence category appear to be fluid and changeable in response to task conditions.

In a further extension of the interdependence construct, Saavedra, Earley, and Van Dyne (1993) defined complex interdependence as a multi-dimensional construct including the interactive effects of task interdependence, goal interdependence, and feedback interdependence. The authors defined task interdependence as the degree to which group members must rely on one another to perform their tasks effectively. This definition

encompasses the sequential, reciprocal, and team interdependence categories described above. In an initial study of complex interdependence, Saavedra, Earley, and Van Dyne (1993) showed team member dyads can differ in their degree of complex interdependence and that differences in interdependence can have important consequences for team performance.

While recognizing team members can be interdependent in multiple ways (i.e., in terms of goals, feedback, and tasks or processes), this paper is concerned only with process interdependence and the influence process interdependence can have on the importance of exchange relationship quality. Just as LMX and TMX have not addressed the differentiated relationships team members perform, they have also ignored the effects of variations in the level of interdependence in team member dyads. I emphasize these differences because of the effects they may have on the relationship between horizontal exchange quality and performance. These effects will be described in a later section.

Relationship symmetry. LMX emphasizes the formal resources leaders may provide in exchange for desired role behavior from their subordinates. According to LMX, if they have any influence on role negotiations at all, subordinates negotiate from a disadvantage because they possess no formal, position-based resources to exchange. Although they lack the positional power and resource differences of vertical relationships, the members of horizontal dyads do possess exchange currency in the form of their own willingness to cooperate and comply with role expectations. The symmetric nature of horizontal relationships is likely to increase the emphasis on negotiation and extend the phase during which roles are negotiated.

Construct Level

A conflict exists between LMX theory and practice as to the level of the relationship quality construct. LMX relationship quality has been defined as a dyadic-level construct (Graen & Cashman, 1975) and LMX theory describes the exchange process as a dyadic phenomenon, involving the repeated interactions of two members over time (Graen

& Scandura, 1987). Although conceptualized as a dyadic-level construct, empirical work has measured and analyzed LMX at the individual level. However, this has not been widely recognized as a problem. For example, in a critique of the LMX model, Dienesch and Liden (1986) cited the lack of use of a single measurement scale as the major methodological issue in LMX research. They did not, however, mention the source of LMX ratings as a potential problem. Similarly, Graen and Scandura (1987) suggested relationship quality can be measured by supervisor or member ratings, making no distinction between the two sources other than to note a possible problem with restriction of range when using supervisor perceptions.

The result of the lack of attention to the source of relationship quality ratings is that some researchers have tended to treat leader and member ratings interchangeably. LMX relationships have been assessed from the perspective of the superior (e.g., Dockery & Steiner, 1990; Graen et al., 1982; Graen & Scandura, 1987), the subordinate (e.g., Dockery & Steiner, 1990; Graen & Scandura, 1987) and the peer group (Duchon et al., 1986). Others (e.g., Dansereau et al., 1975; Dunegan et al., 1992) have assessed relationship quality from one source and used the other source to provide judgments of the antecedents or consequents of relationship quality.

Two rationales have been given for preferring one source of LMX data over another. Some researchers (e.g., Duchon et al., 1986) suggest using different ratings sources to reduce the problem of common sources method bias. From this perspective, the source of the LMX data is not important as long as it differs from the source used to gather other perceptual variables. If one is interested in member satisfaction, satisfaction perceptions should be gathered from members, while LMX perceptions should be gathered from supervisors.

A second rationale for preferring one source over another is to avoid restricted ratings from supervisors when assessing LMX quality in new relationships. A problem noted with the use of supervisor ratings of relationship quality is the reluctance of

supervisors to distinguish among their subordinates. Graen and Scandura (1987) noted the restriction in the range of relationship quality ratings by supervisors is most severe early in the dyadic relationship and that, over time, leaders are more willing to admit they form differentiated relationships with members. However, if member satisfaction in new relationships is the dependent variable of interest, a dilemma emerges in that one must either accept the possible method bias from using the member as the source of both relationship and performance ratings or accept supervisor's restricted LMX ratings. While these two arguments have some merit individually, neither argument fully addresses the problems associated with using leader and member ratings interchangeably.

Empirical results support the presence of systematic differences between leader and member views of relationship quality. While researchers have found significant correlations between leader and member perceptions of relationship quality, the relatively small size of the correlations suggests the measures are not equivalent. For example, Dockery and Steiner (1990) found only a moderate correlation ($r$ = .41) between leader and member perceptions of relationship quality. Duchon et al. (1986) also found moderate correlations between member ratings of exchange quality and leader nominations of in-group and out-group members ($r$ = .42 and .35 at times one and two, respectively). Notice the correlations decrease rather than increase over time. This result is inconsistent with the proposition that the differences in perspectives are due to restricted supervisor ratings and that the restriction in range decreases over time. This result also highlights the problems created by confusing the level of the relationship quality construct.

If LMX is a dyadic construct, one has the option of either measuring LMX at the level of the dyad (i.e., through a single, global measure which assesses LMX) or of somehow aggregating the perceptions of each dyad member (Rousseau, 1985). The practice of using leader and member views of the exchange relationship interchangeably assumes there are no differences in the way superiors and subordinates view their exchange relationship. However, we know that is not the case (Graen & Scandura, 1987).

In addition, the relatively small correlations between leader and member ratings compared to reliability estimates for the measures (e.g., .76 to .84 internal consistency and .80 to .90 stability; Graen & Schiemann, 1978) suggest systematic differences between leader and member ratings other than range restriction do exist.

Critique Summary

Since teams are composed of interdependent members performing differentiated roles, the possibility clearly exists for relationship quality to influence the nature of their interactions. From our own personal experience, we recognize that the quality of some relationships is such that team members are eager to assist each other and to provide each other the information, help, and recognition which facilitates cooperation, teamwork, and coordination. We have also seen other relationships of such low quality that the participants attempt to avoid each other and interact only when absolutely necessary, even to the detriment of their own and the team's performance. Members of such low-quality dyads are enacting a role similar to that of the leader who practices the neglect observed in the vertical relationships of out-group members. In fact, some relationships may be of such low quality that they progress beyond benign neglect to a state of antagonism or open conflict. One can only conclude the relationships between team members are as unique as their participants.

If one accepts that the characteristics of dyads enacting differentiated roles of varying interdependence levels will work to produce team member relationships which are unique and uniquely influential, the nature and effects of horizontal team member relationships become empirical questions. They are, however, questions which have been ignored and which cry for a new approach. In the following section, I present the horizontal member exchange perspective as an approach which clearly defines the level of the relationship quality construct while incorporating the characteristics of teams.

## Horizontal Team Member Exchange (HMX)

The preceding critique suggests the need for a new approach to understanding team member exchange relationships. The basic thesis of this paper is that team members, like leaders and their subordinates, negotiate unique dyadic exchange relationships and that those relationships are relevant to role making outcomes, such as satisfaction and performance. Accounting for the impact of differentiated peer relationships will contribute to understanding team- and individual-level outcomes, especially when the interest is in teams without leaders (e.g., self-managed work teams), action teams whose members are highly interdependent (e.g., Kozlowski, Gully, McHugh, Salas, & Cannon-Bowers, in press), or when there are significant variations in interdependence levels among team member dyads. The horizontal member exchange (HMX) approach is necessary to fill the lacunae in existing perspectives. HMX supplements LMX and TMX by accounting for the impact of peer relationships on team member outcomes. The following sections address the issues discussed in the critique of LMX and TMX research and elaborate the HMX construct.

Differentiated HMX relationships allow for the dyadic role development processes described in the LMX literature to be applied to the peer exchange context. Although LMX and HMX relationships do differ (e.g., HMX relationship are more symmetric and no role taking phase may exist), the basic cycle of sending, receiving, and responding to role expectations should remain the same. Expanding the exchange relationship literature to include HMX relationships allows for a richer understanding of role development (i.e., that roles develop from a synthesis of the role expectations of leader-member dyads, peer dyads, and the peer group). Recall that Seers (1989) claimed dyadic team relationships are not important because team members have no resources to exchange. The issue of what resources team members exchange is addressed in the following section.

The Exchange of Team Member Resources

Graen and Scandura (1987) listed a number of formal resources leaders can exchange for desired role behavior, including inside information, decision making influence, valued task assignments, and task latitude. Because team members lack access to the formal resources available to supervisors, formal rewards and sanctions, such as desirable task assignments, cannot be the basis of horizontal exchange relationships. Team members must exchange something else. However, several of the resources cited by Graen and Scandura (1987) are available to team members. In the following paragraph, I argue that these resources (i.e., information, support, and attention), which can be thought of as forms of cooperation, form the basis for valued exchanges among team members.

One characteristic of teams is that team members must rely on one another to perform their individual tasks (Dyer, 1984; Salas et al., 1992). When team members are interdependent, they must expend time and energy performing the behaviors their teammates expect and on which their team members depend. Thus, the expected role behaviors of interdependent team members can be thought of as informal resources to be exchanged. In a general sense, cooperation, which is the degree to which team members integrate their efforts (Kabanoff & O'Brien, 1979; O'Brien, 1968), provides the resource

base for horizontal member exchange relationships. In HMX relationships, cooperation can be thought of in terms of rewards and sanctions. In return for desired role behaviors, team members can reward or sanction each other with cooperative or uncooperative behaviors.

As described above, leader-member exchange quality is thought to have three aspects. These aspects combine to form a leader or member's unified appraisal of the relationship. Leaders and members develop beliefs about the other member's contributions to the relationship, the loyalty of the other member or the congruence of the other member's goals with the one's own, and affect for, or liking of, the other member (Dienesch & Liden, 1986; Schriesheim, Neider et al., 1992; Schriesheim, Scandura et al., 1992). These three aspects meet Dienesch and Liden's (1986) criteria for exchange currency (e.g., available and mutually valued) among horizontal team member dyads. Team members can exchange cooperative performance behaviors, affect, and loyalty and these aspects can be presumed to be valued due to the differentiated, interdependent nature of team roles.

Level of the HMX Construct

As with the LMX construct, the level of HMX relationship quality must be carefully specified. According to role theory (Katz & Kahn, 1978), roles are negotiated through a dyadic process. While the negotiation process is dyadic, when two team members negotiate a relationship, each will have unique perceptions of the negotiated relationship and each will exhibit different behaviors based on those perceptions. Therefore, HMX quality should be conceptualized and measured at the individual level. It is an individual perception of the quality of an exchange relationship which develops over a series of dyadic interactions.

Measuring exchange relationships at the individual level does not imply a dyadic-level relationship construct could not be formulated. It seems likely an argument could be made for a dyadic-level exchange construct measured by either a global index or by

aggregating individual-level perceptions of relationship quality. The latter approach follows the frequently used approach for measuring organizational climate in which individual-level psychological climate perceptions (e.g., James & Jones, 1974) are aggregated to form a higher level climate variable. However, variables formed as aggregations of individual-level perceptions to represent a higher level construct typically are required to show agreement among the aggregated perceptions (Rousseau, 1988). Since my focus for the HMX construct will be at the level of individual perceptions, demonstrating agreement between dyad members is not a concern. Additionally, I believe our science, in general, should avoid applying Rousseau's (1988) argument too broadly. Whether, or under what circumstances, team members have similar perceptions of their dyadic relationships are important empirical questions, which should not be overlooked in a rush to demonstrate agreement.

Although role making is a dyadic-level process, relationship quality is conceptualized as an individual-level construct. Thus defined, it is appropriate to measure relationship quality from either participant's perspective, although one should carefully consider and justify the source used. For example, using leaders and members as alternate sources to reduce bias from a common source is consistent with this approach. Another advantage of conceptualizing relationship quality as an individual-level perception is that restrictions in range and other systematic differences (e.g. self-serving cognitive biases in recall or attribution; (Feldman, 1981) become phenomenon to be investigated rather than annoyances to be avoided. The importance of specifying the source from which perceptions of relationship quality are measured will become more apparent when a model for the development and impact of the horizontal member exchange construct are presented in a later section.

Among team members, we can expect asymmetries in power and positional resources to be negligible or nonexistent. Thus, team members will establish exchange relationships which are more evenly balanced than vertical relationships. Although only

focal member perceptions were assessed, Seers' (1989) TMX instrument took a somewhat balanced approach to TMX quality as evidenced by the use of items assessing perceptions of willingness to help others as well as others' willingness to provide help. However, the balanced measurement approach conflicted with his theoretical argument, which proposed an asymmetric member-peer group relationship.

An exchange relationship construct and its associated measurement instruments should reflect the balanced nature of the horizontal relationships among team members. For example, when assessing HMX relationship quality, one should address the willingness of the focal team member to help another as well as the focal team member's beliefs about the other team member's willingness to help him or her. This is in direct contrast to the practice in LMX research of focusing only on the behavior and intentions of the leader.

A Conceptual Model of Horizontal Team Member Exchange Quality

Given my conception of horizontal team member relationships and the existing literature on vertical and peer group relationships, it is possible to construct a conceptual model of horizontal relationship quality (Figure 1). Although discussed within the context of team performance, the model functions at the individual level but includes the perceptions of multiple team members. For example, one person's communication effectiveness to another affects the performance of the other person. After providing a brief overview of the model, I will describe the constructs and their relationships in greater detail in the following sections. The model also guided the development of the hypotheses in the study whose results are reported in later sections.

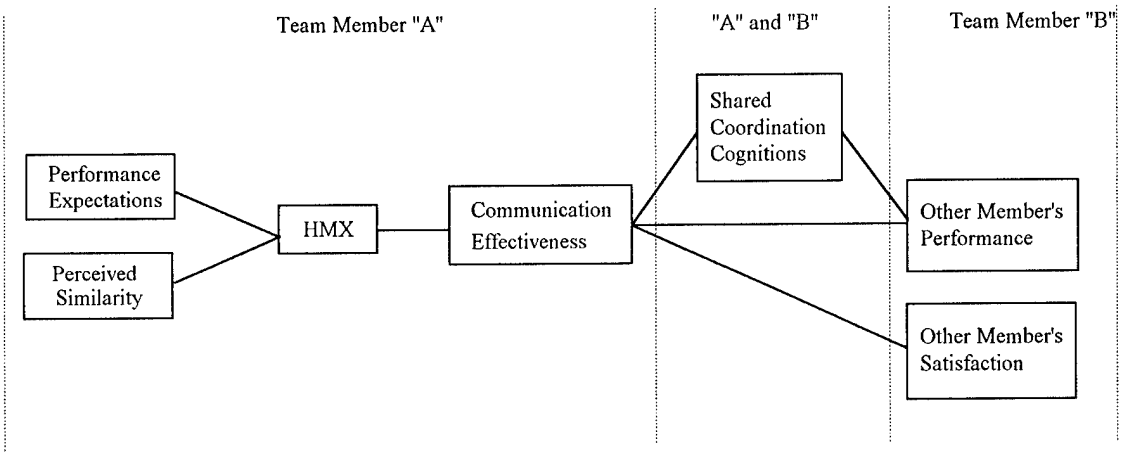


Figure 1. Conceptual model of Horizontal Team Member Exchange (HMX).

Although HMX is the central construct in the model, it is clearly necessary to understand what determines team members' perceptions of the quality of their dyadic working relationships. Results from LMX, TMX, and the Pygmalion effect show that performance expectations and perceived similarity influence perceptions of vertical relationship quality. As shown in the model, they will have similar, positive effects as antecedents of HMX. That is, team members will form higher quality relationships with those teammates for whom they have higher performance expectations and with those teammates they perceive they are more similar.

The next portion of the model depicts the effects of relationship quality. Once a focal member's perceptions of relationship quality have formed, some process must operate to translate them to behaviors which impact team functions. Communication, which serves as the medium of interaction among team members is the process by which perceptions of relationship quality are manifested. Communication effectiveness can be thought of as the degree to which one member communicates information to another in a

timely manner. Just as vertical relationship quality enhances or impoverishes leader-member communications, horizontal relationship quality determines the effectiveness of the communication between team members.

Steiner's (1972) warning about interaction as the point at which process loss occurs, informs us that communication, as an interaction process measure, can affect performance. Beyond the direct effects effective communication may have on performance (i.e., the information provided was correct and allowed a teammate to make a correct, timely decision), the shared mental models literature indicates shared cognitions develop through interaction and can also facilitate performance (e.g., through the ability to predict a teammate's future actions, Cannon-Bowers, Salas, & Converse, 1993). Therefore, the HMX model elaborates the direct relationship between communication and performance by including a communication-performance path which is mediated by shared cognitions. In addition to affecting performance, team members' interactions affect their attitudes. Without correct and timely input from their teammates, team members cannot perform effectively. Ineffective communication between team members is frustrating and dissatisfying because it prevents effective performance. Therefore, satisfaction is represented as an additional outcome of communication effectiveness.

While the HMX model does not attempt to include all possible antecedents and effects of HMX , it represents the relationships with a few constructs which are implicated by other literatures, some of which were testable in the current study. In the following sections, I present more detailed arguments for the paths in the model. These arguments are presented in the general order of the antecedents and then the effects of HMX.

Although arguments are presented for each relationship in Figure 1, not all the paths were tested in the current study. The complexities inherent in studying multiple levels (i.e., individual, dyadic, and team) in a single experiment required choices to be made as to what was possible and practical. These choices also limited the analyses which were appropriate. As I present the hypotheses and analyses, I will note any differences between the conceptual model and the research performed. Also, several of the hypotheses tested the effects of varying interdependence levels, it is not depicted in the model. As will be explained below, interdependence cannot be represented or tested as a traditional moderating effect. The manner in which the effects of varying interdependence levels were tested will be elaborated in a later section.

The model presented in Figure 1 depicts a number of relationships and is fairly complex. The use of several submodels will simplify the presentation of theoretical arguments as well as illustrate how the current research design and analysis differed from the theoretical model. The numbered pathways in these submodels correspond to the numbers of the hypotheses presented in the following sections. The first submodel (Figure 2) depicts the relationship between performance expectations, perceived similarity manipulations, and HMX quality.

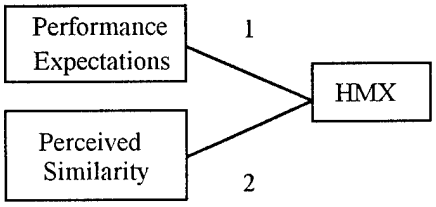


Figure 2. The effects of performance expectations and perceived similarity on HMX.

Performance Expectations. As described above, performance has been depicted as both a cause and consequence of vertical relationship quality. While it is probable the two

are reciprocally related (i.e., relationship quality enhances performance opportunities, which enables higher performance, which enhances relationship quality), some LMX research indicates there are situations in which performance, or more specifically, performance expectations, precede perceptions of relationship quality. In a study of initial interactions in which dyad participants had no prior opportunity to assess contributions to the relationship, leader perceptions of member ability were highly correlated with leader perceptions of relationship quality (Dockery & Steiner, 1990). Similarly, Kim and Organ (1982) experimentally increased subjects' intent to form a high quality vertical relationship by manipulating perceptions of subordinate ability. These studies suggest, at least in some circumstances, expected contributions, rather than actual contributions, can influence the quality of vertical relationships. These studies also considered the entire vertical exchange relationship (i.e., performance, affect, and trust). Other research (i.e., the Pygmalion and Golem aspects of self-fulfilling prophecies) address only a portion of the working relationship and can be thought of as dealing with a subset of LMX phenomena.

Two types of self fulfilling prophecy research focus directly on the effects of expectations on performance. The Pygmalion effect occurs when high performance expectations for another person result in actual performance gains for that person (Eden, 1988). The Golem effect represents the reverse case; low performance expectations for another person result in actual decreases in their performance (Oz & Eden, 1994). Although these phenomena are most firmly established in the classroom (e.g., Thorndike, 1968), they have been demonstrated to operate in work settings as well. For example, Pygmalion effects have been found in military training programs (Eden & Ravid, 1982; Eden & Shani, 1982), doctoral programs (Chapman & McCauley, 1993), and in whole operational military units (Eden, 1990). The Golem effect has also been demonstrated in military units (Oz & Eden, 1994).

Eden and Shani (1982) suggested the leader-subordinate relationship provides the mechanism by which leader expectations influence subordinate performance. Graen and

Scandura (1987) have also interpreted the link between expectations and relationship quality in Pygmalion terms. However, according to Eden's (1984) model of leadership and the Pygmalion effect, differences in leadership stemming from expectancy effects serve to elevate subordinate self-motivation. That is, leaders with high expectations of a person treat that person well, which elevates their self-motivation. Eden's (1984) model predicts that the increase in subordinate performance is due only to increases in their self-motivation. The model makes no provision for the more direct facilitating effects preferential leader treatment may have on subordinate performance.

This is in direct contrast to LMX, which suggests in-group members perform better because of preferential treatment from their leader; that is, in-group members perform better because they get the best assignments, the most support, and the most information (Dansereau et al., 1975). When Graen and Scandura (1987) said supervisors imposed a self-fulfilling prophecy on new members, their interpretation included no mention of subordinate motivation. Likewise, Eden's own research on the Pygmalion effect suggests subordinate motivation is not the only mechanism involved.

For example, Eden and Shani (1982) found expectancies have a very strong impact on subordinate perceptions. Leader beliefs about the aptitude of military trainees accounted for 28% of the variance in soldiers' perceptions of leader behavior. When leaders had higher performance expectations for their subordinates, those subordinates believed the leader provided them more support and facilitated their work and interactions. These are the same behaviors leaders provide for in-group members. They are also behaviors which are likely to directly facilitate subordinate performance.

The educational and organizational literature on the Pygmalion effect focuses on the beneficial effects of expectations in vertical relationships. LMX also predicts that leader expectations will affect subordinate performance. Unfortunately, organizational researchers have not determined whether Pygmalion effects operate in the horizontal relationships among team members. One question is whether the Pygmalion effect will

operate in the absence of the large power and resource differentials found in vertical relationships.

The motivational pathway suggested by Eden (1984) may, indeed, depend heavily on the presence of resource and power differentials between the sender and recipient of performance expectations. That is, motivation may be responsive to expectancies only when they are received from higher status individuals, such as leaders. Interdependence, however, insures that performance gains can be directly facilitated by the behavior of the other party (i.e., the member holding the performance expectations). Thus, although the motivational pathway becomes less important in horizontal dyads because of reduced status differentials, expectancy effects are still likely to occur through the direct performance facilitation which can result from elevated expectations. Such direct facilitation is likely to occur in horizontal as well as vertical dyads and HMX serves as a mediator between expectations and performance.

Accordingly, I propose that horizontal relationship quality will be affected by the expectations team members have for each others' performance. Team members who are perceived as being very capable and likely to be high performers, become assets to be tapped. For interdependent team members, the capable teammate has the potential to contribute to one's own performance. For independent team members, the capable teammate is an asset to the team overall. Team members will readily transmit their expectations to this person and offer their own resources in exchange for desired role behavior. That is, team members will attempt to form high quality relationships with the members they expect will be most able to help them. In new dyads, when team members have not had a chance to observe performance, they will determine expected performance based on whatever information they have about the other person. This includes information about the general mental ability of others.

$H_1$: HMX quality will be higher when focal members have higher expectations for the performance of the other dyad member.

Perceived Similarity. A second precursor of horizontal relationship quality of interest in this study is perceived similarity. When Dienesch and Liden (1986) discussed the dimensionality of vertical relationship quality, they included an affective component. In their view, LMX includes the mutual affection between dyad members. They also specified that the affective component of LMX was based on interpersonal attraction. Byrne's (1971) model of interpersonal attraction categorizes the types of variables which determine interpersonal attraction. In addition to being determined by propinquity, the need for affiliation, and overt characteristics (e.g., physical attractiveness), Byrne (1971) claimed interpersonal attraction was most responsive to whether or not the relationship is perceived as being positive or negative. Relationships are perceived as more positive when they are formed with people who are thought to be similar, rather than dissimilar, to oneself.

The influence of several types of similarity (i.e., perceived similarity, perceptual congruence, and actual similarity; Turban & Jones, 1988) has been studied in the context of selection and performance evaluation and a direct link between similarity, liking, and evaluation is sometimes made (e.g., Schmitt, Nason, Whitney, & Pulakos, 1994). For example, Orpen (1984) found the degree to which interviewers perceived themselves to be similar to applicants affected both how much they liked the applicants and whether they decided to hire those applicants. Actual similarity between two people has been shown to influence performance ratings when rater and ratee have similar educational backgrounds (Zalesny & Kirsch, 1989) or similar social attitudes (Wexley, Alexander, Greenawalt, & Couch, 1980). The latter study found that perceptual congruence in attitudes, which has been defined as the degree to which subordinates accurately perceive their manager's attitudes, was a better predictor of performance ratings than was actual similarity in attitudes (Wexley & Pulakos, 1983).

Finally, some evidence exists that similarity may not lead to liking or positive affect in all people. Three admissions officers who each evaluated multiple candidates showed

high, low, and zero relationships between a personal profile which varied in terms of actual similarity to their own and liking (Frank & Hackman, 1975). It is not clear, however, whether the admissions officers perceived themselves to be similar to those applicants who actually had similar profiles.

Some research has compared the relative influence of actual and perceived similarity. Turban and Jones (1988) measured perceived similarity with items which assessed perceived similarity in outlook, perspective, values, and work habits. They found the degree to which subordinates perceived they were similar to their supervisor was significantly related to subordinate job satisfaction. Turban and Jones (1988) also found supervisor's perceptions of similarity to their subordinates were a better predictor of subordinate performance ratings and pay recommendations than were either actual similarity or perceptual congruence.

Research has also supported the greater influence of perceived similarity relative to actual similarity. For example, Pulakos and Wexley (1983) found a stronger relationship between performance ratings and perceived similarity versus actual similarity. They concluded their findings supported Byrne's (1971) model of interpersonal attraction. In addition, they linked perceived similarity to the quality of vertical exchange relationships and the frequency and effectiveness of communications between leader and subordinate. An interesting finding in the study was that if either dyad member perceived they were similar to the other, the leader continued to support the subordinate and facilitate their work. This raises the question, why would a leader support a subordinate with whom they felt they had a poor quality relationship? Thus, although exchange quality appears to be sensitive to perceptions of similarity, some aspects of their relationship are still unclear.

In teams, perceptions of similarity should also have positive effects on horizontal relationship quality. Team members who perceive themselves to be similar to each other will perceive their relationship to be rewarding, which will generate positive affect. Since

positive affect is a component of relationship quality, those team members will also be more likely to initiate and maintain high quality relationships.

$H_2$: HMX quality will be higher when focal members perceive themselves to be more similar to the other dyad member.

HMX, interdependence, and performance. The next submodel portrays the effects of interdependence on the relationship between HMX, performance, and satisfaction (Figure 3). Recall that Figure 1 did not represent the impact of varying levels of interdependence between team member dyads. This is because although the hypotheses concerning the interdependence effects sound like the typical moderation hypotheses, they cannot be tested with the traditional hierarchical regression procedure (e.g., Cohen & Cohen, 1983).

This situation can best be understood as follows. Consider the case of a three person team. Team member "A" is highly interdependent with "B" but has a low level of interdependence with "C." The impact of the level of HMX for both "B" and "C" on the performance of team member "A" is of interest. The usual test of moderation would involve a three variables; HMX, interdependence (high and low), and an interaction term. However, in this scenario, two HMX predictors exist (i.e., B and C's perceptions of their relationship quality with A. Also, only a single performance score for A exists. Therefore, the hypothesis will be made that B's HMX will have a stronger effect on A than will C's because "A" and "B" are more interdependent than "C" and "A."

To distinguish the hypothesized interdependence effects from the usual depiction of a moderating path, Figure 3 presents two submodels portraying the relatively stronger or weaker effects of HMX when team member are more or less interdependent. Figure 3 also does not contain the mediating process variables (i.e., communication effectiveness and shared cognitions) in Figure 1. Although Figure 1 depicts their theoretical importance, conducting the analyses as portrayed in Figure 3 enables the interdependence

hypotheses to be assessed. The methods and analyses sections will further elaborate these issues.

Some psychologists have argued general mental ability is the single best predictor of individual performance and the search for incrementally valid predictors is likely to be unsuccessful (Ree & Earles, 1992). While this claim may be debated for some time (McClelland, 1993; Ree & Earles, 1993), the strong relationship between general mental ability and individual performance is based on the assumption that individual performance results from characteristics of the individual in isolation from others. In team settings, individuals are interdependent such that individual performance depends on the behavior of others. In terms of process interdependence, when the output of one team members depend on another's inputs, individual performance becomes a function of individual ability plus the factors which affect the interaction between team members. Although LMX research suggests relationship quality is a major factor affecting the interaction between leaders and all team members, in horizontal relationships, interdependence level becomes an additional consideration.

One aspect all vertical dyads share is that leaders and members are always interdependent. The leader depends on the member for role performance and the member depends on the leader for reward and support. In-group and out-group member role performance may differ in importance to the leader (i.e., in-group member performance is more important to the success of the unit) but even mundane tasks must be completed. The same is not true of team member dyads. While all team members may be interdependent in that they share a common goal or outcome (e.g., win a game or extinguish a fire), dyads within the team may vary in their degree of interdependence. For example, two firefighters maneuvering a hose are more interdependent than are either of them with a third firefighter who cordons off the area to prevent spectators from approaching too closely. Although all three may share the same overall goal, the first dyad has more process interdependence than the latter two.

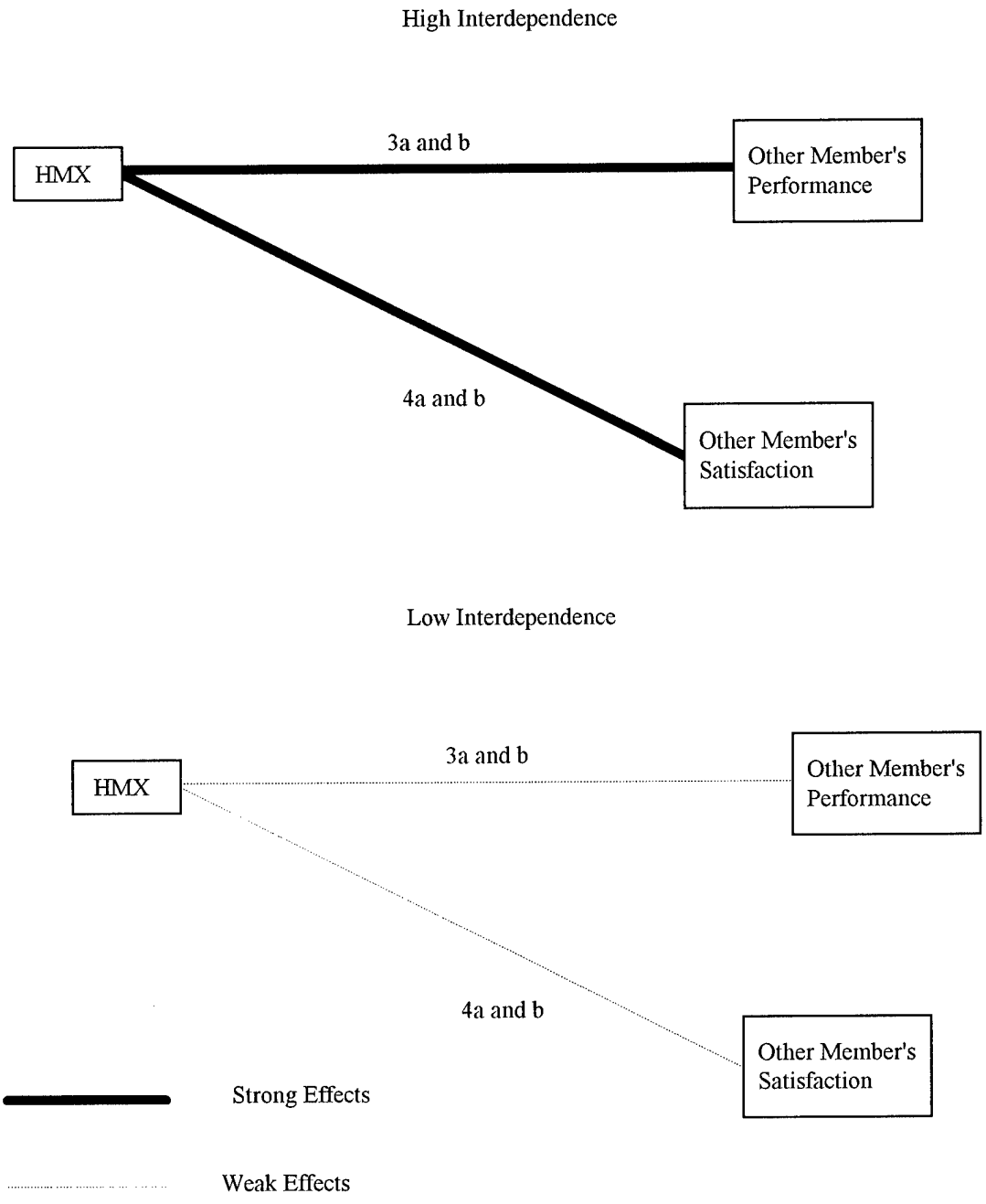


Figure 3. The effects of HMX under conditions of high and low interdependence.

When two team members perform their tasks relatively independently, such as one firefighter who cordons off a safe perimeter and another who maneuvers a water hose, they have less need to share information, ideas, and feedback. Thus, the quality of their exchange relationship, which determines how information is shared, should have little impact on their individual performance. Although exchange relationship quality may determine the effectiveness of communications within the dyad, that communication is not critical to their individual task performance because the tasks do not require the members to interact to any great extent. Conversely, exchange relationships between highly interdependent members can greatly impact the performance of single members and the entire team. For example, the failure of a military squad member to warn a teammate of a dangerous situation is intimately linked to the second team member's performance and, ultimately, the performance of the squad. A fireman failing to tell his partner that he is about to shift his grip on a hose may cause both members to loose their footing, injure themselves and loose control of the hose. A running back on a football team will gain less yardage without effective communication about speed or direction within the running back-blocker dyad. These highly interdependent dyads cannot survive or be effective if they do not communicate effectively.

When the nature of an interdependent relationship is that team members must exchange information to perform their tasks, one can expect low quality exchange relationships to hamper performance due to the resulting ineffectiveness of communications between the dyad members. Because team member performance depends on effective relationships in addition to individual ability, the effects of HMX quality will be distinct from the level of team member ability. In addition, the impact of relationship quality on performance will depend on the degree of interdependence between the team members. When team members are less independent, relationship quality will have smaller effects on performance.

$H_{3a}$: Perceptions of HMX quality will predict teammate performance beyond the effects of teammate ability.

$H_{3b}$: The relationship between HMX quality and performance will be stronger when team members are more interdependent.

HMX, interdependence and satisfaction. The link between performance expectations and satisfaction has not been directly addressed in the literature on vertical exchange relationships. Higher satisfaction is commonly found in higher quality vertical relationships (e.g., Graen et al., 1982; Stepina et al., 1991; Vecchio & Gobdel, 1984) but, to my knowledge, no study has manipulated performance expectations to investigate the relationship between exchange quality and satisfaction. However, the Eden and Shani (1982) study directly linked performance expectations and attitudes. In that study, performance expectancies accounted for an 66% of the variance in soldiers' attitudes. The attitudes affected included motivation to continue in training, overall satisfaction, and willingness to recommend the training to others. Although, Eden and Shani (1982) thought the effects of expectations on attitudes were mediated by the quality of the vertical relationship between leader and member their study was not able to confirm this relationship.

In horizontal exchange relationships, the same pathway will operate such that performance expectations will affect satisfaction through their effects on relationship quality. Also, because performance expectations can only be transmitted during interactions, the degree of interdependence, which determines the amount of required interaction, will affect the relationship between relationship quality and satisfaction, such that when members are highly interdependent, the relationship between HMX and satisfaction will be stronger.

$H_{4a}$: HMX quality will be positively associated with the satisfaction of the other dyad member.

$H_{4b}$: The relationship between HMX quality and satisfaction will be stronger when team members are more interdependent.

HMX and communication effectiveness. The final submodel depicts communication effectiveness as a mediating process between HMX and its outcomes (Figure 4). Figure 4 also portrays the direct and indirect (through shared coordination cognitions) paths between effective communications, performance, and satisfaction.

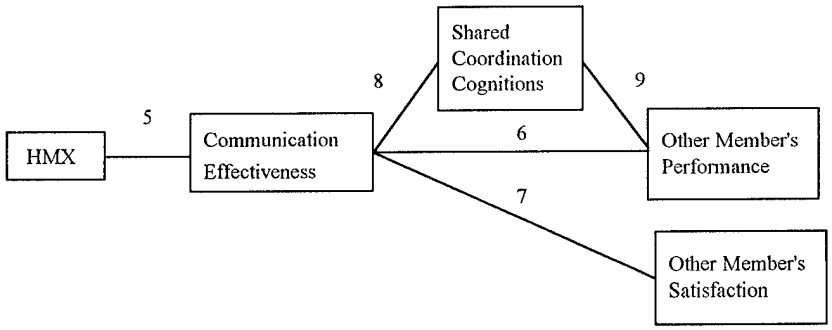


Figure 4. Communication effectiveness as a mediating process variable.

The Eden and Shani (1982) study demonstrated the dramatic effects vertical relationships can have on other people's performance. One can also ask how horizontal relationship quality is linked to performance and satisfaction; by what process does relationship quality affect performance? The performance expectancy manipulation in the Eden and Shani (1982) military training study accounted for an amazing 73% of the variance in objective measures of learning and 66% of the variance in soldiers' attitudes (i.e., motivation to continue in training, satisfaction, and willingness to recommend the training to others). Thus, when leaders had higher performance expectations for their subordinates, those subordinates performed better on objective measures even though they

were matched on ability with others whom leaders believed were of moderate or unknown ability.

Eden and Shani (1982) concluded the gains in actual performance were produced by performance expectations effects on motivation and were transmitted through the leadership and supervisory behaviors associated with relationship quality. Leaders communicated their expectations and subordinates became motivated and responded. Graen and Scandura (1987) also believed relationship quality and the self-fulfilling prophecy are connected by the differential treatment leaders show their subordinates. They stated the following concerning the leader behavior observed in the Graen, Orris, and Johnson (1973) study.

> For those whom they (i.e., supervisors) predicted would leave, they invested a minimum of time and energy. At times, they practiced "benign neglect." In contrast, for those whom they predicted would stay, they invested a good deal of time and energy in their development and care. (Graen & Scandura, 1987, p. 195, parenthetical remark not in original)

Not only did leaders fail to communicate high expectations to out-group members, they ignored those members, expecting them to perform only the duties formally required by their job description.

In interdependent teams where performance clearly depends on effective communication, the effects of low quality exchange relationships could have devastating consequences for out-group member performance. In fact, Seers (1989) defined TMX in terms of the willingness of the peer group to share ideas, information, and feedback, all of which can be thought of as contributing to effective communication. If one's performance depends on information supplied by teammates, their willingness to do so will be critical.

If the effects of horizontal relationship quality are as strong as is found in vertical relationships, the impact of differential relationship quality should be clearly visible through team member communication behaviors. Team members who believe they have a high quality relationship with another will be more willing to communicate ideas and share feedback with that teammate.

In the sections above, communication behavior between team members has been shown to be both critical to individual and team performance as well as sensitive to vertical relationship quality. In addition to the positive effects of high quality relationships, team members may exhibit the same tendency to restrict communications with low relationship quality partners. Thus, one can expect low quality HMX relationships to create impoverished and ineffective communication relative to higher quality HMX relationships. The effectiveness of the communications between team members will also directly impact individual performance and satisfaction.

$H_5$: Members who perceive they have a better HMX relationship with another dyad member will communicate more effectively with the other member.

$H_6$: Communication effectiveness will have a positive relationship with member performance.

$H_7$: Communication effectiveness will have a positive relationship with member satisfaction.

Shared cognitions. To perform their interdependent, differentiated roles, team members must communicate effectively and coordinate their actions in time. These requirements are especially important when teams perform swiftly paced action tasks

(Kozlowski et al., in press). Fleishman and Zaccaro (1992) labeled such requirements the response coordination team function, which they described as the sequence of actions and responses required by the team task as well as the specific requirements for the time and place of role behavior performance. Shared cognitions, often referred to as shared mental models or team mental models, have been proposed as a factor which facilitates the response coordination function in teams (e.g., Klimoski & Mohammed, 1994; Orasanu & Salas, 1993; Cannon-Bowers et al., 1993). Shared cognitions facilitate the response coordination function by creating shared expectations for behavior among team members. When team members can predict how their teammates will react to task or situational stimuli, they can more easily coordinate their behavior and adapt to changes in the state of the system (Cannon-Bowers et al., 1993).

Cannon-Bowers et al. (1993) also suggested that team members form multiple models of the team context, including models of their equipment and their individual tasks. In addition, team members form models of how they will interact with their teammates. These models contain information about team roles and responsibilities, information sources, interaction patterns, communication channels, and role interdependencies. Coordinated action among team members on fast paced tasks requires shared expectations as to the functioning of the team due to the lack of time to explicitly coordinate behavior through discussion. That is, team members must be able to anticipate how their teammates will respond to the environment and plan their own actions accordingly.

In the communication literature, Krauss and Fussell (1990) discussed shared cognitions in terms of mutual knowledge, which is "knowledge that the communicating

parties both share and know they share" (p. 112). The authors cited direct interaction as one mechanism by which people develop shared cognitions. Klimoski and Mohammed (1994) linked shared cognitions and role making by claiming both include the same content (e.g., expected behavior or role expectations). They went on to suggest increased communication may facilitate the development of shared cognitions. Other researchers have directly linked the development of shared cognitions to the repeated interactions which occur during role making. For example, Graen and Scandura (1987) suggested leaders and members develop shared, dyadic understanding through the communications which occur over the repeated interactions of the role making process.

Although a number of theoretical and empirical articles have suggested shared cognitive structures are important for effective team performance, the empirical evidence is mixed and primarily utilizes shared mental models as a post-hoc explanation of results. For example, Kleinman and Serfaty (1989) found more effective tactical decision making teams were able to coordinate their actions even under high workloads. As a post hoc explanation, the authors attributed the ability of the better performing teams to coordinate their actions to the shared knowledge structures team members had developed. Presumably, members of the better teams had developed shared understandings of their response coordination requirements. On the other hand, London (1975) failed to find performance differences on a brainstorming task performed by three-person groups provided with heterogeneous (nonshared) or homogeneous (shared) information. However, groups with heterogeneous information did exhibit greater process loss (Steiner,

1972) in several areas, such as giving and receiving information, peer ratings of effectiveness, and favorableness of the group atmosphere.

Although there are many alternative methods for assessing shared cognitions (Klimoski & Mohammed, 1994; Rouse & Morris, 1986), one alternative is to assess agreement as a form of shared understanding. Two LMX studies have linked relationship quality and levels of agreement. Graen and Schiemann (1978) found greater agreement in high- than low-quality vertical dyads on the severity of 21 problems commonly experienced on the job and on 32 items assessing the relationship itself. After subjects were trichotomized by LMX score (top 25%, middle 50%, and bottom 25%), the authors found members with high and middle quality relationships showed greater agreement with their leaders than members with low quality relationships. The authors concluded leaders acquired more accurate information about in-group members relative to out-group members. As a result, leaders and members of the high quality relationships developed more similar interpretations of mutually experienced events.

Kozlowski and Doherty (1989) argued vertical relationship quality affects climate perceptions in two ways. First, in-group members are likely to have more positive climate perceptions because the interactions with their leader are more positive than those of out-group members. Second, high quality relationships provide more opportunity for leaders and members to interact, which allows them to share and discuss their climate perceptions. As the authors hypothesized, in-group members had more positive climate perceptions. The authors also found greater agreement among in-group members relative to out-group members on several aspects of organizational climate. On those aspects, in-group

members showed more agreement among themselves and, most importantly, in-group members showed more agreement with their supervisors.

Although these two studies investigated agreement in vertical relationships, the interaction process cited as the basis for the results obtained also operates in horizontal dyads. Horizontal relationship quality will determine communication effectiveness by either facilitating or restricting the interactions which enable the formation of shared cognitions. Communication effectiveness will affect the formation of shared coordination cognitions because of the opportunity effective communication provides to exchange and discuss coordination routines. In teams in which members must coordinate their actions, shared coordination cognitions will, in turn, increase performance because of the improved coordination they enable.

$H_8$: Team members who communicate more effectively will have more similar coordination cognitions.

$H_9$: Shared coordination cognitions will increase individual performance.

HMX and team performance. My final hypotheses concerns the relationship between HMX and team performance. I have already argued that HMX can affect the performance of individual team members. The relationship between HMX and team performance follows because individual and team performance are related according to the type of team task involved.

Steiner (1972) described several types of team tasks which combine individual performance in different ways. For example, the output of group tasks in which members perform independent roles can be a simple sum of the individual outputs. Since teams are

assumed to perform tasks which involve at least some interdependencies, team performance will be something other than the sum or average of individual performance. Individual performance can combine such that team performance depends on the performance of the weakest or strongest member. Alternately, some team tasks are not compensatory such that all team members must perform well for the team to accomplish its task. Tasks may also combine these characteristics in complex ways, such that some measures of team output may depend on the weakest link yet other measures require all members to perform well. In general, however, one should expect a positive relationship between individual and team performance. Thus, when individuals perform poorly, team performance suffers. As noted above, the level of relationship quality is one of the determinants of individual performance in teams. Therefore, teams with higher HMX levels should perform better. In addition, the relationship between HMX and team performance will depend on the degree of interdependence among members. HMX will be important to team performance when members are interdependent. That is when the effects of HMX on communication effectiveness become critical to individual and team performance.

$H_{10a}$: The relationship between HMX quality and team performance will be positive.

$H_{10b}$: The relationship between HMX quality and team performance will be stronger when team members are more interdependent.

## Method

The study used a two by two (performance expectations and perceived similarity) between subjects design. Interdependence relationships (high or low) within teams were forced by the simulation design and were fixed across teams and conditions.

### Subjects

The subjects were 276 undergraduate students who received psychology class credit and $5.00 for their participation. Subjects were randomly assigned to conditions and to one of three team positions ( Alpha, Bravo, and Charlie) to form 92 teams. One hundred sixty eight subjects were female and 108 were male.

### Simulation

Three person teams performed the Tactical Naval Decision Making (TANDEM) simulation (cite) using networked IBM compatible, 33 MHz personal computer stations equipped with a color monitor, keyboard, and three button mouse. Participants were seated at tables approximately 3-5 feet apart and could see and talk with each other. To increase the fidelity of the setting to a naval decision making task, participants communicated via headsets and microphones. The lighting in the room was subdued and military nautical and aeronautical charts and paraphernalia lined the walls. The experimenter wore a military uniform during all contact with the participants.

The simulation required team members to access pull-down menus with the mouse, look-up target information on their simulated radar screen, and make decide how to classify and engage those targets. The operator manuals provided to subjects contained keys which enabled them to interpret the target information, classify, and engage each

target. Target information and decisions were distributed such that team members were required to share information and coordinate their activities to completely engage a target. Interdependence relationships among team dyads were varied by varying the degree to which the dyads were required to share information and coordinate their actions.

Manipulations

The intent of the performance expectations manipulation was to increase or decrease the expectations team members Bravo and Charlie held about Alpha without directly affecting the self-efficacy of any team member. The intent of the perceived similarity manipulation was to increase or decrease the degree to which team members Bravo and Charlie perceived their teamwork attitudes were similar to Alpha's attitudes. The manipulations were implemented by providing subjects bogus feedback on the results of an ability test and a team personality and attitudes test. The feedback sheets differed across team member positions and across conditions.

Performance expectations. Prior to performing the simulation, all three team members completed the Wonderlic test of general mental ability. The experimenter scored the tests and provided all the subjects bogus feedback about the results of the test in the form of a feedback sheet containing the "scores" of all the team members. In the high expectations condition, the feedback forms provided to Bravo and Charlie indicated Alpha scored "30" on the ability test and that Alpha's score fell in the very high ability category. In the "low expectations" condition, the feedback forms provided to Bravo and Charlie indicated Alpha scored "9" on the ability test and that Alpha's score fell in the very low ability category. To avoid manipulating self-efficacy, the scores each team member saw

always showed their own score as being slightly above average. To increase the salience of the test information, subjects were shown the scores for one minute and told they would be asked to reproduce the scores at the end of the experiment. All team members were also told the test had proven to be an accurate predictor of simulation performance in the past.

Perceived similarity. Bravo and Charlie's beliefs about the similarity of their personality and team attitude scores to Alpha's scores were also manipulated through the bogus feedback forms. In the "low similarity" condition, the feedback forms provided to Bravo and Charlie indicated there was a high degree of dissimilarity between their own scores and Alpha's scores. In the "high similarity" condition, the feedback forms provided to Bravo and Charlie indicated there was a high degree of similarity between their own scores and Alpha's scores. The feedback forms for Bravo and Charlie showed their own scores as varying randomly in similarity to each other. Alpha's feedback form showed a random pattern of similarity to Bravo and Charlie. The manipulation script and feedback forms provided to subjects in each of the four conditions are contained in Appendix A.

Interdependence relationships. By design, the dyads in the three person teams varied in their level of process interdependence. The simulation required team members Alpha and Bravo to work closely while team member Charlie was able to work relatively independently of his or her teammates. Variation in the level of process interdependence was implemented by varying the requirements for communication between members and the degree to which the dyads were required to sequence their actions.

The interdependence relationships forced by the simulation are illustrated in Figure 6. The letters designate the team members Alpha, Bravo, and Charlie. The arrows indicate the direction in which team members were required to pass information. Alpha and Bravo were highly interdependent, while Charlie had low communication and coordination requirements with Alpha and Bravo. All three positions were interdependent in terms of team outcomes.

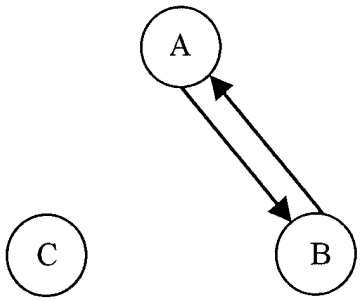


Figure 5. Communication interdependence relationships among team members.

To make accurate decisions, Alpha and Bravo were required to exchange target information. Charlie's task did not require providing information to Alpha or Bravo or receiving information from them. However, the team could not engage a target until all members, including Charlie, had made the decision for which they were responsible.

Alpha's task was designed as follows. Alpha was responsible for determining the Class of a target, which involved deciding whether the target was civilian or military. Alpha's console menu contained two information cues to make the Class decision and a cue required to make the Intent decision. The Class cues available to Alpha always

disagreed, forcing Alpha to rely on a cue available from Bravo to make the correct Class decision. The Class of a target could not be assigned until after the Type of the Target was determined by Charlie.

Bravo's task was designed as follows. Bravo was responsible for determining the Intent of each target (hostile or peaceful) and for Engaging each target (shoot or clear the target from the area). Bravo's console menu contained two cues required to make the Intent decision as well as the cue Alpha needed to make the Class decision. As in Alpha's task, the two cues available to Bravo always disagreed, forcing Bravo to depend on Alpha to provide a third piece of information, which determined the Intent of the target. Bravo was able to make the Engage decision based on the outcome of the Intent decision but could only engage a target after the Type, Class, and Intent decisions for that target were made.

Charlie's task was designed as follows. Charlie was responsible for determining the Class of each target (air, submarine, or surface vessel). Charlie's console menu contained all the cues required to make the Type decision and those cues always agreed. Charlie was generally able to process a target faster than Alpha or Bravo, which allowed Charlie to either wait for his or her teammates or move ahead of the rest of the team and prosecute targets as quickly as possible.

Measures

The first two measures were part of the performance expectations and perceived similarity manipulations and were not central to the hypotheses. Nonetheless, descriptive statistics for these two measure are included in the results. General mental ability was

assessed with the 12 minute short form of the Wonderlic Personnel Test. The team personality and attitudes questionnaire (Appendix B) was the 20 item individualism/collectivism measure used by Wagner (in press). Subjects responded to the items using a seven-point scale, ranging from "Strongly Agree" to "Strongly Disagree."

Horizontal member exchange quality was the central construct in the study. A 14 item measure of HMX (Appendix C) was created based on Dienesch and Liden's (1986) proposition that exchange relationships are a unitary concept composed of three aspects (affect, trust, and performance). The measure contained items assessing those aspects of HMX, as well as items assessing the overall quality of the working relationship. Items were adapted slightly to be used both before and after simulation performance. Items were rated on a seven-point scale, ranging from "Strongly Agree" to "Strongly Disagree." Also, the measure given to each team member differed slightly as it specifically referenced the other members of the team by their position names. For example, the questionnaire Alpha completed asked about the quality of Alpha's relationship with Bravo and Charlie.

An 18 item measure of coordination cognitions (Appendix D) was created to assess the beliefs of each team member about how the simulation should be performed. The items assessed specific procedures and coordination routines which teams may have developed over the course of the simulation. Items were written in pairs in which one item assessed the degree to which one member agreed the task should be performed in a certain way. The second item of the pair asked whether the member thought their teammate would agree that the task should be performed in that manner. The

coordination cognition items were rated using a seven-point scale, ranging from "Strongly Agree" to "Strongly Disagree."

A ten item satisfaction measure (Appendix E) was also developed. The items in the measure assessed satisfaction with multiple aspects of the experiment, including satisfaction with their own performance and their team's performance, satisfaction with their teammates, and satisfaction with their job on the team. The items were rated on a seven-point scale, which ranged from "Extremely Dissatisfied" to "Extremely Satisfied."

Communication effectiveness assessed the degree to which Bravo provided Alpha the assistance and support Alpha needed to perform the simulation. The effectiveness of Bravo's communication to Alpha was measured by two methods. For the first method, Alpha completed an eight item scale assessing the effectiveness of Bravo's communications (Appendix F). Items were rated on a seven-point scale, which ranged from "Strongly Disagree" to "Strongly Agree."

Because the speed of Alpha's task performance depended, in part, on the speed at which Bravo supplied cue information, a key component of communication effectiveness was the timeliness with which Bravo responded to Alpha's information needs. Since Alpha could not make the Class decision until Bravo provided cue information about a target, the latency of Alpha's Class decision averaged over all targets engaged provided an additional measure of Bravo's communication effectiveness. The average latency (over the targets engaged) of the Class decision was calculated as the average time between when the previous target was engaged and when the Class decision was made.

Simulation performance was measured at the individual and team levels by the TANDEM program. At the individual level, the program assessed the number of decisions made by Alpha, the number of incorrect decisions, and the proportion of decisions correctly made. At the team level, the performance measures included the number of targets engaged by the team, the number of targets incorrectly engaged, and the proportion of targets correctly engaged by the team. These three measures were intended to assess both the speed and accuracy with which Alpha and the entire team performed the simulation.

Procedures

Subjects were randomly assigned to conditions and team positions and scheduled to attend a laboratory session. Upon arrival, subjects were briefed on the study and asked to read and complete a consent form (Appendix G). The experimenter read the manipulation script to the subjects and then administered the Wonderlic and team personality and attitude tests. After the tests, subjects were given 10 minutes to read the TANDEM manual, which provided the information necessary to interpret cue information and make decisions. During that time, the experimenter pretended to score the tests and prepare feedback forms for each team member.

The bogus feedback forms were then given to the subjects to implement the manipulations. When given the feedback sheets, subjects were told they had one minute to study the sheets. They were also told that as an additional memory test they would be required to reproduce as much of the test information about themselves and their teammates as possible at the end of the experiment. After the manipulations, subjects

were provided ten minutes of hands-on training on console operation and were guided through the decision process for five targets. The training also included instruction on the communication requirements for team members Alpha and Bravo. Subjects then subjects completed the first HMX measure.

Subjects were instructed to engage the targets in order from the center of the screen outward. This insured all teams engaged the same targets and further reduced the Charlie's process interdependence with Alpha and Bravo because it eliminated the need for the team to coordinate with Charlie on which target to engage. Subjects then performed the simulation, attempting to engage as many targets as possible. All team communication was recorded and videotapes were also made of Bravo's computer screen.

After the simulation, Alpha and Bravo completed the coordination cognitions measure. Alpha also completed the rated communication effectiveness measure and all subjects completed the satisfaction measure and the second HMX measure. Subjects were debriefed (Appendix H) and released. The total session lasted approximately 2 hours.

## Results

### Analytical Issues

Several analytical issues arose due to the complexity inherent in studying teams in which the members performed interdependent yet differentiated roles. The first issue was the complexity created by working at multiple levels (i.e., individual, dyad, and team). Because of the multiple levels of interest and the multiple sources of data available for some analyses (e.g., communication effectiveness was available for team members Alpha

and Bravo), more than one sample size was used in the analyses. I have attempted to ease the reader's task by clarifying the level of focus for each analysis.

A second issue concerned the logistical difficulty of conducting team research (e.g., availability of subjects and the time required to collect team-level data). A relatively small sample size resulted, which decreased the power of the significance tests to detect small effects. The combination of a small sample size and the exploratory nature of the central constructs and measures involved led me to adopt a significance level of .10 in rejecting the null hypothesis. Significance levels of .10 and .05 are presented in the analyses. One-sided tests were used to further increase the power of the analyses when sufficient theoretical rationale existed to predict the direction of an effect. For the regression analyses, this was implemented with one-tailed *t*-tests on standardized regression (beta) weights. For the analyses of the differential effects of high- and low-interdependence HMX, the tests took the form of one-tailed *Z*-tests of transformed correlations and multiple correlations.

A third issue was the unusual nature of the hypotheses which assessed the relative impact of high- and low-interdependence exchange relationships. The primary method of analysis directly tested the hypotheses but is not commonly used. This method directly assesses the significance of the difference in predictiveness of two variables or sets of variables from dependent samples. Comparing the uniquenesses of variables or sets of variables by reversing their order entry in a hierarchical regression is a less stringent but more commonly used approach to discerning relative contributions to prediction. Where appropriate, both methods are presented.

A fourth issue was the treatment of the second measure of relationship quality. As described in the procedure, the second relationship quality assessment took place immediately after the completion of the simulation. Although the assessment was made after performance ended, it was treated as a cause of performance because the relationship quality items addressed the state of the relationship during the simulation.

Descriptive Statistics

Data screening and final sample. Because the hypotheses included analyses at the team level, if data for any team member were missing or unusable, the entire team was eliminated from the sample to maintain a single, consistent data set. As a result, data from ten teams were discarded for the following reasons. Four teams were eliminated because their data were unusable (i.e., responses out of sequence on the machine graded answer sheet or the simulation data were lost to computer or operator error). Three teams were discarded because their members said they had seen that the feedback sheets their teammates received were different than theirs. This led them to disbelieve and disregard the manipulations. One team was discarded because a team member with a heavy accent could not be understood by the other team members. The data from another team was unusable because a subject could not understand and follow the directions for operating the simulation. The session was completed but, in the judgment of the experimenter, the data were unusable because of the degree of assistance from the experimenter the subject required. The final team was discarded because the individual and the entire team were extreme outliers on all the performance measures (i.e., three plus standard deviations) and appeared to have been familiar with the simulation before starting the experiment.

After eliminating the ten teams described above, 82 teams remained, consisting of 149 females and 97 males. Table 1 lists the number of teams and team members in each of the four experimental conditions.

Table 1
Number of teams/subjects per condition

| Similarity | Performance Expectations | |
|---|---|---|
| | High | Low |
| High | 22/66 | 19/57 |
| Low | 18/54 | 23/69 |

Reverse item coding. Several of the questionnaires contained items which were negatively worded. Those items were reversed so a higher score always indicated a consistent direction. Items 1 through 10, 12, and 18 through 20 of Wagner's (in press) individualism/collectivism scale, were reverse coded so a higher response on all items indicated increased collectivism. Items 5 through 10 on the coordination cognitions scale were reverse coded so a higher response on all items indicated a consistent method of coordinating task performance. Items two, four, six, and eight on the communication effectiveness scale were reverse coded so a higher response on all items indicated increasing communication effectiveness. All subsequent analyses were performed with the reverse coded items.

Scale reliability. Scale scores for the HMX, communication effectiveness, coordination cognitions, and satisfaction scales were created by averaging the unit-weighted items after coding all items in a consistent direction. Examination of the item

intercorrelations for the coordination cognitions scale indicated the deletion of items 11 and 12 , which dealt with the coordination of actions with team member Charlie, would improve the reliability of the scale. After examining their content, I deleted those items. The change led to a minimal increase in coefficient alpha (i.e., from .84 to .87) but was consistent with the intent to measure Alpha and Bravo's coordination cognitions. All subsequent analyses were performed with items 11 and 12 deleted from the scale. All the scales demonstrated acceptable internal consistency reliabilities, with the lowest being .68 for the first dimension of the individualism/collectivism scale.

Basic statistics. Table 2 contains the mean, standard deviation, and internal consistency reliability of the measures. Where appropriate, statistics are provided for subgroupings of the measures, such as for individual team positions. Although the individualism/collectivism (Wagner, in press) measure was used only as a prop to implement the perceived similarity manipulation, statistics for the full measure and its five subscales are included in Table 2. The first and second measurements of HMX are designated HMX-I and HMX-II, respectively.

Table 2
Variable Means, Standard Deviations and Scale Reliabilities

| Variable | *M* | *SD* | *r*[a] |
|---|---|---|---|
| General Mental Ability (*N* = 246) | 26.17 | 4.97 | |
| Alpha (*n* = 82) | 25.79 | 4.67 | |
| Bravo (*n* = 82) | 26.45 | 5.44 | |
| Charlie (*n* = 82) | 26.27 | 4.81 | |
| Individualism/Collectivism (*N* = 246) | 4.82 | 0.57 | .72 |
| Alpha (*n* = 82) | 4.78 | 0.59 | |
| Bravo (*n* = 82) | 4.90 | 0.56 | |
| Charlie (*n* = 82) | 4.79 | 0.56 | |
| C1-Personal Independence (*N* = 246) | 4.11 | 1.09 | .68 |
| Alpha (*n* = 82) | 4.06 | 1.08 | |
| Bravo (*n* = 82) | 4.20 | 1.04 | |
| Charlie (*n* = 82) | 4.07 | 1.17 | |
| C2-Competition (*N* = 246) | 4.47 | 1.00 | .70 |
| Alpha (*n* = 82) | 4.32 | 1.06 | |
| Bravo (*n* = 82) | 4.65 | 0.94 | |
| Charlie (*n* = 82) | 4.45 | 0.98 | |
| C3-Working Alone (*N* = 246) | 4.33 | 1.37 | .89 |
| Alpha (*n* = 82) | 4.54 | 1.41 | |
| Bravo (*n* = 82) | 4.38 | 1.21 | |
| Charlie (*n* = 82) | 4.07 | 1.45 | |
| C4-Subordination to Grp. (*N* = 246) | 5.83 | 0.68 | .76 |
| Alpha (*n* = 82) | 5.89 | 0.75 | |
| Bravo (*n* = 82) | 5.77 | 0.75 | |
| Charlie (*n* = 82) | 5.82 | 0.54 | |
| C5-Personal Pursuits (*N* = 246) | 5.67 | 1.12 | .77 |
| Alpha (*n* = 82) | 5.48 | 1.27 | |
| Bravo (*n* = 82) | 5.71 | 1.02 | |
| Charlie (*n* = 82) | 5.83 | 1.03 | |

[a] r - internal consistency reliability.

Table 2 (cont'd)

| Variable | *M* | *SD* | *r* |
|---|---|---|---|
| HMX- I ($N = 492^a$) | 5.29 | 0.86 | .94 |
| w/Alpha ($n = 164$) | 5.12 | 1.06 | .95 |
| Bravo w/Alpha ($n = 82$) | 5.18 | 0.99 | |
| Charlie w/Alpha ($n = 82$) | 5.07 | 1.12 | |
| w/Bravo ($n = 164$) | 5.42 | 0.70 | .93 |
| Alpha w/Bravo ($n = 82$) | 5.43 | 0.74 | |
| Charlie w/Bravo ($n = 82$) | 5.40 | 0.66 | |
| w/Charlie ($n = 164$) | 5.34 | 0.78 | .95 |
| Alpha w/Charlie ($n = 82$) | 5.41 | 0.77 | |
| Bravo w/Charlie ($n = 82$) | 5.27 | 0.78 | |
| HMX-II ($N = 492^a$) | 5.57 | 0.91 | .96 |
| w/Alpha ($n = 164$) | 5.58 | 0.88 | .95 |
| Bravo w/Alpha ($n = 82$) | 5.65 | 0.95 | |
| Charlie w/Alpha ($n = 82$) | 5.51 | 0.80 | |
| w/Bravo ($n = 164$) | 5.66 | 0.91 | .96 |
| Alpha w/Bravo ($n = 82$) | 5.79 | 0.96 | |
| Charlie w/Bravo ($n = 82$) | 5.54 | 0.84 | |
| w/Charlie ($n = 164$) | 5.46 | 0.93 | .96 |
| Alpha w/Charlie ($n = 82$) | 5.50 | 1.00 | |
| Bravo w/Charlie ($n = 82$) | 5.42 | 0.87 | |

[a] Each team member rated their relationship quality with each other team member, doubling the effective sample size.

Table 2 (cont'd)

| Variable | *M* | *SD* | *r* |
|---|---|---|---|
| Coordination Cognitions ($n$ = 164) | 5.97 | 0.76 | .87 |
| Alpha ($n$ = 82) | 5.97 | 0.75 | .88 |
| Bravo ($n$ = 82) | 5.78 | 0.73 | .87 |
| | | | |
| Communication Effectiveness ($N$ = 328) | 5.51 | 1.05 | .90 |
| Bravo's Effectiveness ($n$ = 164) | 5.62 | 0.99 | .90 |
| Alpha's Ratings ($n$ = 82) | 5.90 | 0.85 | .85 |
| Charlie's Ratings ($n$ = 82) | 5.34 | 1.04 | |
| | | | |
| Alpha's Effectiveness ($N$ = 164) | 5.43 | 1.09 | .90 |
| Bravo's Ratings ($n$ = 82) | 5.51 | 1.07 | |
| Charlie's Ratings ($n$ = 82) | 5.27 | 1.11 | |
| | | | |
| Alpha's Avg. Dec. Time ($n$ = 82) | 25.43 | 8.05 | |
| | | | |
| Satisfaction - Full Scale ($N$ = 246) | 5.71 | 0.82 | .87 |
| Alpha ($n$ = 82) | 5.83 | 0.87 | .92 |
| Bravo ($n$ = 82) | 5.76 | 0.83 | |
| Charlie ($n$ = 82) | 5.53 | 0.74 | |
| | | | |
| Satisfaction w/Teammates ($N$ = 246) | 5.82 | 0.85 | .82 |
| Alpha ($n$ = 82) | 5.92 | 0.90 | .88 |
| Bravo ($n$ = 82) | 5.82 | 0.87 | |
| Charlie ($n$ = 82) | 5.73 | 0.76 | |

Table 2 (cont'd)

| Variable | *M* | *SD* |
|---|---|---|
| Individual Task Performance | | |
| Alpha ($n$ = 82) | | |
| Number of Decisions | 44.52 | 11.00 |
| Number Incorrect | 4.65 | 4.03 |
| Proportion Correct | 0.89 | 0.11 |
| Bravo ($n$ = 82) | | |
| Number of Decisions | 45.49 | 11.17 |
| Number Incorrect | 3.71 | 3.89 |
| Proportion Correct | 0.91 | 0.10 |
| Charlie ($n$ = 82) | | |
| Number of Decisions | 51.34 | 17.81 |
| Number Incorrect | 1.70 | 1.06 |
| Proportion Correct | 0.96 | 0.03 |
| Team Performance ($n$ = 82) | | |
| Number of Targets Engaged | 43.02 | 11.11 |
| Number Incorrect | 6.77 | 0.15 |
| Proportion Correct | 0.82 | 0.15 |

Table 3 contains the variable intercorrelations. To make the table more manageable, several of the subdivisions used in Table 2 as well as the individualism/collectivism scale were excluded from the matrix. Individualism/collectivism was excluded because it was intended only as a ruse to implement the manipulations.

Two of the team performance variables exhibited unacceptable levels of skew or kurtosis (i.e., over 1.0). Following procedures outlined by Tabachnick and Fidell (1989), transformations were used to force those scores toward a normal distribution. The natural log of the number of incorrect team decisions and the proportion of correct team decisions was taken. In addition, the proportion of correct team decisions was reflected to avoid analyzing variables of opposite skew. The reader is reminded at relevant points in the analyses that the reflection reversed the direction of the expected results. The transformed variables appear below the original variables in Table 3. In some cases the transformation decreased correlations by a small amount (e.g., .01 - .02) but in others (e.g., the correlation between the proportion of correct team decision and Bravo's HMX-II with Alpha) the correlation increased by as much as .11.

Table 3
Correlations of Original and Transformed Variables

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Performance Expectations (1) | 1.00 | | | | | | | | |
| Perceived Similarity (2) | .10 | 1.00 | | | | | | | |
| A's Ability (3) | .11 | -.02 | 1.00 | | | | | | |
| A's HMX-I w/B (4) | .16 | -.01 | -.18 | 1.00 | | | | | |
| A's HMX-I w/C (5) | .11 | .05 | .05 | *.50 | 1.00 | | | | |
| A's HMX-II w/B (6) | .01 | .09 | -.04 | *.25 | *.25 | 1.00 | | | |
| A's HMX-II w/C (7) | .01 | .06 | .15 | *.21 | *.34 | *.63 | 1.00 | | |
| B' s HMX-I w/A (8) | *.47 | *.41 | .08 | *.33 | .13 | .17 | *.24 | 1.00 | |
| B's HMX-I w/C (9) | -.12 | .02 | -.13 | .13 | .03 | .05 | -.03 | .11 | 1.00 |

Notes: "A," "B," and "C" refer to team positions Alpha, Bravo, and Charlie. Correlations of transformed variables are listed below the original correlations. Individualism/collectivism was not included in the table because it was used only as a ruse in the manipulation. $n$ = 82.
* $p \leq .05$.

Table 3 (cont'd)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B's HMX-II w/A (10) | *.30 | .16 | .12 | *.27 | *.24 | *.49 | *.35 | *.49 | .10 | 1.00 | | | | | |
| B's HMX-II w/C (11) | .09 | .12 | .09 | *.33 | .04 | *.37 | *.33 | *.40 | *.37 | *.60 | 1.00 | | | | |
| C's HMX-I w/A (12) | .19 | *.44 | .05 | .19 | *.27 | .17 | .19 | *.32 | .06 | .16 | .02 | 1.00 | | | |
| C's HMX-I w/B (13) | .02 | -.07 | -.21 | .21 | .16 | .06 | .06 | .01 | .06 | .06 | .18 | .20 | 1.00 | | |
| C's HMX-II w/A (14) | .10 | .02 | .21 | -.03 | .11 | .20 | .20 | .09 | -.05 | .16 | .20 | .19 | .12 | 1.00 | |
| C's HMX-II w/B (15) | .01 | .04 | .01 | -.04 | .00 | .19 | .21 | .08 | .02 | .06 | *.26 | .09 | *.37 | *.76 | 1.00 |
| B's Comm. Effect. (16) | .07 | .10 | -.10 | *.36 | *.28 | *.46 | *.38 | .15 | .01 | *.26 | .16 | *.21 | -.09 | *.25 | .17 |
| A's Avg. Dec. Time (17) | *-.22 | .05 | *-.46 | .10 | -.07 | -.12 | -.08 | -.01 | .17 | -.17 | -.11 | .15 | .13 | *-.25 | -.13 |

Table 3 (cont'd)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Similarity of Coord. Cog. (18) | -.18 | .04 | -.09 | *.31 | *.23 | -.04 | .01 | -.08 | .00 | -.15 | -.19 | .04 | -.02 | -.05 | -.07 |
| A's Satisfaction Full Scale (19) | .09 | .00 | *.22 | .14 | *.28 | *.62 | *.70 | .13 | -.06 | *.33 | *.23 | .16 | .02 | *.32 | *.24 |
| A's Satisfaction w/Team (20) | .10 | .02 | *.25 | .17 | *.27 | *.57 | *.71 | .18 | -.05 | *.33 | *.26 | .15 | -.01 | *.29 | *.26 |
| A's # Decisions (21) | .14 | .00 | *.30 | .00 | .06 | .19 | .05 | -.03 | -.12 | *.23 | .14 | .04 | -.08 | *.22 | .17 |
| A's # Incorrect Decisions (22) | -.16 | .03 | *-.26 | .15 | -.14 | *-.28 | *-.43 | -.15 | .03 | *-.23 | -.18 | -.14 | -.08 | *-.29 | *-.30 |
| A's Prop. Correct Decisions (23) | .15 | -.01 | *.37 | -.17 | .19 | *.29 | *.42 | .09 | -.07 | *.27 | .19 | .12 | .02 | *.42 | *.36 |

Table 3 (cont'd)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Team's # Decisions (24) | .11 | -.02 | *.30 | .01 | .07 | *.22 | .08 | -.04 | -.11 | *.23 | .15 | .04 | -.06 | *.23 | .19 |
| Team's # Incorrect Decisions (25) | *-.28 | .03 | *-.22 | .08 | -.03 | *-.40 | *-.40 | *-.23 | .04 | *-.50 | *-.26 | -.08 | -.06 | *-.22 | *-.21 |
| | *-.22 | .06 | -.13 | .13 | .02 | *-.36 | *-.38 | -.18 | .13 | *-.49 | *-.24 | -.08 | -.14 | *-.31 | *-.32 |
| Team's Prop. Correct Decisions (26) | *.21 | -.03 | *.35 | -.03 | .07 | *.36 | *.39 | .06 | -.11 | *.41 | *.27 | .07 | .03 | *.37 | *.30 |
| | *-.22 | .03 | *-.31 | .08 | -.09 | *-.43 | *-.38 | -.16 | .08 | *-.52 | *-.28 | -.07 | -.02 | *-.37 | *-.31 |
| A's Sex (27) | .03 | .15 | .00 | .15 | .05 | .10 | .07 | .09 | .08 | .02 | .12 | .16 | -.03 | .12 | .12 |
| B's Sex (28) | -.09 | -.12 | .12 | .06 | -.05 | -.08 | .02 | -.06 | .19 | .10 | .20 | -.08 | .15 | .03 | -.02 |
| C's Sex (29) | *-.22 | .00 | .00 | .05 | .05 | .15 | .14 | -.09 | .09 | .04 | .06 | .17 | .12 | .05 | .11 |

Table 3 (cont'd)

| | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| B's Comm. Effect. (16) | 1.00 | | | | | | | | | | |
| A's Avg. Dec. Time (17) | -.02 | 1.00 | | | | | | | | | |
| Similarity of Coord. Cog. (18) | *.23 | .00 | 1.00 | | | | | | | | |
| A's Satisfaction Full Scale (19) | *.57 | *-.36 | .05 | 1.00 | | | | | | | |
| A's Satisfaction w/Team (20) | *.60 | *-.33 | .07 | *.96 | 1.00 | | | | | | |
| A's # Decisions (21) | *.23 | *-.74 | -.07 | *.37 | *.37 | 1.00 | | | | | |
| A's # Incorrect Decisions (22) | *-.27 | .19 | *.23 | *-.47 | *-.51 | -.07 | 1.00 | | | | |
| A's Prop. Correct Decisions (23) | *.35 | *-.46 | -.19 | *.58 | *.60 | *.40 | *-.90 | 1.00 | | | |
| Team's # Decisions (24) | *.25 | *-.72 | .07 | *.39 | *.40 | *.99 | -.09 | *.41 | 1.00 | | |
| Team's # Incorrect Decisions (25) | *-.29<br>*-.34 | *.22<br>.19 | *.29<br>*.25 | *.47<br>*.46 | *-.49<br>*-.48 | .14<br>-.18 | *.77<br>*.70 | *-.71<br>*-.68 | -.14<br>-.19 | 1.00 | |
| Team's Prop. Correct Decisions (26) | *.40<br>*-.40 | *-.47<br>*.45 | *-.23<br>*.24 | *-.61<br>*.59 | *.60<br>*-.60 | *.47<br>*-.47 | *-.69<br>*.69 | *.82<br>*-.82 | *.47<br>*-.47 | *-.89<br>*.88 | 1.00 |

Table 3 (cont'd)

| | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A's | | | | | | | | | | -.06 | .13 | | | |
| Sex (27) | *.41 | -.04 | *.25 | *.25 | *.24 | .09 | -.02 | .09 | .11 | -.05 | -.12 | 1.00 | | |
| B's | | | | | | | | | | -.16 | .08 | | | |
| Sex (28) | -.14 | .01 | -.04 | -.07 | -.13 | *-.21 | .00 | -.04 | *-.22 | -.08 | -.07 | -.12 | 1.00 | |
| C's | | | | | | | | | | -.03 | .07 | | | |
| Sex (29) | *.23 | .08 | .01 | *.23 | .20 | -.00 | -.08 | .06 | .03 | -.07 | -.07 | .19 | .14 | 1.00 |

Hypotheses

$H_1$: HMX quality will be higher when focal members have higher expectations for the performance of the other dyad member.

$H_2$: HMX quality will be higher when focal members perceive themselves to be more similar to the other dyad member.

The tests for hypotheses one and two assessed the effects of the manipulations on Bravo and Charlie's HMX with Alpha. The focal level was the individual's perceptions of his or her relationship quality with team member Alpha. Using both Bravo and Charlie's ratings of their relationship quality with Alpha doubled the effective sample size. The beta weights for performance expectations (PE) and perceived similarity (PS) were tested against the following hypotheses. $H_o$: $\beta_1 = \beta_2 = 0$; $H_a$: $\beta_1, \beta_2 > 0$; where $\beta_1$ was the weight for PE and $\beta_2$ was the weight for PS. Table 4 shows the results of the regression of team member Bravo and Charlie's first and second ratings of relationship quality with team member Alpha on the dummy coded manipulations. The manipulations were dummy coded consistent with the hypotheses (i.e., higher performance expectations and perceived similarity were predicted to result in positive beta weights).

Table 4

Regression of HMX on Performance Expectations and Perceived Similarity ($n$ = 164)

| Dependent Variable: Bravo and Charlie's HMX-I with Alpha | | | | |
|---|---|---|---|---|
| Independent Variables | *B* | β | *t* | $sr^2$ (unique) |
| Performance Expectations | 0.58 | .28 | 4.08** | .08 |
| Perceived Similarity | 0.84 | .40 | 5.89** | .16 |
| Intercept | 4.42 | | | |
| | | | $R$ = | .51 |
| *df* = (2, 161) | $F = 28.24^{\dagger\dagger}$ | | $R^2$ = | .26 |
| | | | Adjusted $R^2$ = | .25[a] |

| Dependent Variable: Bravo and Charlie's HMX-II with Alpha | | | | |
|---|---|---|---|---|
| Independent Variables | *B* | β | *t* | $sr^2$ (unique) |
| Performance Expectations | 0.35 | .20 | 2.59** | .04 |
| Perceived Similarity | 0.13 | .07 | 0.95 | .01 |
| Intercept | 5.34 | | | |
| | | | $R$ = | .22 |
| *df* = (2, 161) | $F = 4.08^{\dagger\dagger}$ | | $R^2$ = | .05 |
| | | | Adjusted $R^2$ = | .04[a] |

[a] Wherry (1931).

**$p < .05$, one-tailed. $^{\dagger\dagger}p < .05$.

Hypotheses one and two were supported for the initial HMX measure. As predicted, the beta weights for performance expectations and perceived similarity were positive and significant, indicating the manipulations were effective in influencing Bravo and Charlie's initial perceptions of relationship quality with Alpha. The effect of perceived similarity on HMX was over 50% larger than the effect for performance expectations ($\beta$ = .40 vs. .28, respectively). For the second HMX measure, $H_1$ was supported but $H_2$ was not. In addition, the relative size of the effects was reversed from the initial HMX measure. The effects of the performance expectations manipulation decreased over the course of the simulation from $sr^2$ = .08 to .04 but significantly influenced HMX even at the end of the session.

$H_{3a}$: Perceptions of HMX quality will predict teammate performance beyond the effects of teammate ability.

To test hypothesis 3a, Bravo and Charlie's first and second evaluations of their relationship quality with team member Alpha were entered as independent variables in hierarchical linear regression equations. Alpha's performance measures, which the dependent variables, included the number of individual decisions made, the number of incorrect decisions made, and the proportion of decisions correctly made. The analysis was conducted at the individual level. Alpha's score on the Wonderlic test of general mental ability was entered in the first step of the hierarchical regression to control for the effects of ability level. In step two, the two relationship quality measures (i.e., Bravo and Charlie's HMX toward Alpha) were entered simultaneously. The *F*-test for the change in

variance in performance explained in step two served as the test of hypothesis $H_{3a}$ ($H_o$: $\Delta R^2 = 0$; $H_a$: $\Delta R^2 > 0$).

Results from the regressions of performance on the first and second HMX measures are shown in Tables 5 and 6, respectively. Hypothesis 3a was not supported for the initial assessment of relationship quality for any of the performance measures. Although general mental ability predicted all task performance measures, The first HMX measure did not account for any additional variance in Alpha's performance. The hypothesis was supported for the second assessment of HMX, with HMX explaining an additional 6 to 15% of performance variance (Table 6). The greatest increase in performance variance explained was for the prediction of the proportion of correct decisions made by Alpha (15%). The full equation statistics for this measure show that the unique contributions of the two HMX variables total nearly double the uniqueness of general mental ability, indicating the strong and distinct effects of HMX on performance.

The contributions of HMX to the prediction of performance in the absence of general mental ability are shown in the correlation matrix (Table 2). All six of the first-order correlations between Bravo and Charlie's second HMX ratings and Alpha's three performance ratings were significant ($r$ = .22 to .42). Despite "g's" strong record as an excellent predictor of performance, the first order correlations between Charlie's second HMX ratings with Alpha and Alpha's number of incorrect decisions and proportion of correct decisions were greater than the corresponding correlations between Alpha's ability and performance scores.

Table 5

Hierarchical Regression of Individual Performance on HMX-I ($n = 82$)

| Dependent Variable: Number of Decisions | | | | | |
|---|---|---|---|---|---|
| Step | Independent Variables | *df* | $R^2$ | $\Delta R^2$ | $\Delta F$ |
| 1 | General Mental Ability | 1, 80 | .09 | .09 | 8.01†† |
| 2 | Bravo's HMX w/Alpha<br>Charlie's HMX w/Alpha | 3, 78 | .10 | .00 | 0.21 |

Full Equation Statistics

| Independent Variables | *B* | β | *t* | $sr^2$ (unique) |
|---|---|---|---|---|
| General Mental Ability | 0.72 | .31 | 2.82** | .09 |
| Bravo's HMX w/Alpha | -0.76 | -.07 | -0.60 | .00 |
| Charlie's HMX w/Alpha | 0.45 | .05 | 0.40 | .00 |
| Intercept | 27.64 | | | |
| | | | $R$ = | .31 |
| *df* = (3, 78) | $F = 2.75$†† | | $R^2$ = | .10 |
| | | | Adjusted $R^2$ = | .06[a] |

| Dependent Variable: Number of Incorrect Decisions | | | | | |
|---|---|---|---|---|---|
| Step | Independent Variables | *df* | $R^2$ | $\Delta R^2$ | $\Delta F$ |
| 1 | General Mental Ability | 1, 80 | .07 | .07 | 5.94†† |
| 2 | Bravo's HMX w/Alpha<br>Charlie's HMX w/Alpha | 3, 78 | .09 | .03 | 1.09 |

Full Equation Statistics

| Variables | *B* | β | *t* | $sr^2$ (unique) |
|---|---|---|---|---|
| General Mental Ability | -0.22 | -.25 | 2.31** | .06 |
| Bravo's HMX w/Alpha | -0.40 | -.10 | -0.87 | .01 |
| Charlie's HMX w/Alpha | -0.35 | -.10 | -0.86 | .01 |
| Intercept | 14.09 | | | |
| | | | $R$ = | .31 |
| *df* = (3, 78) | $F = 2.71$†† | | $R^2$ = | .09 |
| | | | Adjusted $R^2$ = | .06[a] |

[a]Wherry (1931).

**$p < .05$, one-tailed. ††$p < .05$.

Table 5 (cont'd)

| Dependent Variable: Proportion of Correct Decisions | | | | | |
|---|---|---|---|---|---|
| Step | Independent Variables | *df* | $R^2$ | $\Delta R^2$ | $\Delta F$ |
| 1 | General Mental Ability | 1, 80 | .14 | .14 | 12.60†† |
| 2 | Bravo's HMX w/Alpha<br>Charlie's HMX w/Alpha | 3, 78 | .15 | .01 | 0.48 |

Full Equation Statistics

| Independent Variables | *B* | β | *t* | $sr^2$ (unique) |
|---|---|---|---|---|
| General Mental Ability | 0.00 | .36 | 3.45** | .13 |
| Bravo's HMX w/Alpha | 0.01 | .03 | 0.31 | .00 |
| Charlie's HMX w/Alpha | 0.01 | .09 | 0.78 | .01 |
| Intercept | 0.61 | | | |
| | | | $R$ = | .38 |
| *df* = (3, 78) | $F = 4.46^{††}$ | | $R^2$ = | .15 |
| | | | Adjusted $R^2$ = | .11[a] |

[a]Wherry (1931).

**$p < .05$, one-tailed. ††$p < .05$.

Table 6

Hierarchical Regression of Individual Performance on HMX-II ($n$ = 82)

| Dependent Variable: Number of Decisions | | | | | |
|---|---|---|---|---|---|
| Step | Independent Variables | *df* | $R^2$ | $\Delta R^2$ | $\Delta F$ |
| 1 | General Mental Ability | 1, 80 | .09 | .09 | 8.01†† |
| 2 | Bravo's HMX w/Alpha<br>Charlie's HMX w/Alpha | 3, 78 | .15 | .06 | 2.65† |

Full Equation Statistics

| Independent Variables | *B* | β | *t* | $sr^2$ (unique) |
|---|---|---|---|---|
| General Mental Ability | 0.59 | .25 | 2.35** | .06 |
| Bravo's HMX w/Alpha | 2.13 | .18 | 1.72** | .03 |
| Charlie's HMX w/Alpha | 1.89 | .14 | 1.27 | .02 |
| Intercept | 6.79 | | | |
| | | | $R$ = | .39 |
| *df* = (3, 78) | $F$ = 4.55†† | | $R^2$ = | .15 |
| | | | Adjusted $R^2$ = | .12[a] |

| Dependent Variable: Number of Incorrect Decisions | | | | | |
|---|---|---|---|---|---|
| Step | Variables | *df* | $R^2$ | $\Delta R^2$ | $\Delta F$ |
| 1 | General Mental Ability | 1, 80 | .07 | .07 | 5.94†† |
| 2 | Bravo's HMX w/Alpha<br>Charlie's HMX w/Alpha | 3, 78 | .16 | .09 | 4.12†† |

Full Equation Statistics

| Variables | *B* | β | *t* | $sr^2$ (unique) |
|---|---|---|---|---|
| General Mental Ability | -0.17 | -.20 | -1.83** | .04 |
| Bravo's HMX w/Alpha | -0.74 | -.17 | -1.64* | .03 |
| Charlie's HMX w/Alpha | -1.14 | -.23 | -2.10** | .05 |
| Intercept | 19.47 | | | |
| | | | $R$ = | .40 |
| *df* = (3, 78) | $F$ = 4.88†† | | $R^2$ = | .16 |
| | | | Adjusted $R^2$ = | .13[a] |

[a]Wherry (1931).

*$p$ < .10, one-tailed. **$p$ < .05, one-tailed. †$p$ < .10. ††$p$ < .05.

Table 6 (cont'd)

| Dependent Variable: Proportion of Correct Decisions | | | | | |
|---|---|---|---|---|---|
| Step | Independent Variables | *df* | $R^2$ | $\Delta R^2$ | $\Delta F$ |
| 1 | General Mental Ability | 1, 80 | .14 | .14 | 12.60†† |
| 2 | Bravo's HMX w/Alpha<br>Charlie's HMX w/Alpha | 3, 78 | .29 | .15 | 8.38†† |

Full Equation Statistics

| Variables | *B* | β | *t* | $sr^2$ (unique) |
|---|---|---|---|---|
| General Mental Ability | 0.01 | .28 | 2.84** | .07 |
| Bravo's HMX w/Alpha | 0.02 | .19 | 1.92** | .03 |
| Charlie's HMX w/Alpha | 0.04 | .33 | 3.32** | .10 |
| Intercept | 0.36 | | | |
| | | | $R$ = | .54 |
| *df* = (3, 78) | $F = 10.57^{††}$ | | $R^2$ = | .29 |
| | | | Adjusted $R^2$ = | .26[a] |

[a]Wherry (1931).
**$p < .05$, one-tailed. ††$p < .05$.

$H_{3b}$: The relationship between HMX quality and performance will be stronger when team members are more interdependent.

Because interdependence levels varied within teams rather than between teams, this factor could not be subjected to the typical test for moderation (i.e., cross product term). Instead, the relative strengths of the correlations of Bravo and Charlie's HMX with Alpha's performance, accounting for their intercorrelation, were tested. A dependent samples *Z*-test assessed the following hypotheses: $H_o$: $r_{hi} = r_{low}$; $H_a$: $r_{hi} > r_{low}$; where $r_{hi}$ is the correlation of Bravo's HMX with performance and $r_{low}$ is the correlation of Charlie's HMX with performance. Because none of the comparisons met the assumptions of the test (i.e., $r_{hi}$ was significant and the relative difference was in the predicted direction), hypothesis 3b was not supported. Table 7 contains the values for the comparisons.

Table 7

Relative Effects of High and Low Interdependence HMX on Performance ($n$ = 82)

| Dependent Variable: Number of Decisions | | | | |
|---|---|---|---|---|
| | $r_{y,hi}$ | $r_{y,lo}$ | $r_{hi,lo}$ | $Z$ |
| HMX-I | -.03 | .04 | .32 | -- |
| HMX-II | .21 | .22 | .16 | -- |

| Dependent Variable: Number of Incorrect Decisions | | | | |
|---|---|---|---|---|
| | $r_{y,hi}$ | $r_{y,lo}$ | $r_{hi,lo}$ | $Z$ |
| HMX-I | -.15 | -.14 | .32 | -- |
| HMX-II | -.23 | -.29 | .16 | -- |

| Dependent Variable: Proportion of Correct Decisions | | | | |
|---|---|---|---|---|
| | $r_{y,hi}$ | $r_{y,lo}$ | $r_{hi,lo}$ | $Z$ |
| HMX-I | .09 | .12 | .32 | -- |
| HMX-II | .27 | .42 | .16 | -- |

Note. The test was a one-tailed $Z$-test for dependent samples (Tabachnick & Fidell, 1989). The cells without $Z$ values did not meet the assumptions of the test (i.e., significant correlation for high interdependence HMX and difference between correlations in the predicted direction).

$H_{4a}$: HMX quality will be positively associated with the satisfaction of the other dyad member.

For hypothesis 4a, Bravo and Charlie's HMX with Alpha were entered as two independent variables predicting Alpha's satisfaction. They were entered simultaneously and the *F*-test was used to test the amount of satisfaction variance explained. Table 8 shows the results of the regressions of satisfaction with teammate and overall satisfaction on the first and second HMX measures.

The first HMX assessment did not explain a significant proportion of the variance in either satisfaction with teammates or overall satisfaction. However, by the time of the second measurement, Bravo and Charlie's evaluation of their relationship quality with Alpha did significantly predict Alpha's satisfaction (both with teammates and overall). In fact, Bravo and Charlie's perceptions of their relationship quality with Alpha determined between 16% and 19% of the variance in Alpha's satisfaction ratings.

Table 8
Regression of Satisfaction on HMX ($n$ = 82)

| Dependent Variable: Alpha's Satisfaction with Teammates | | | | |
|---|---|---|---|---|
| Independent Variables | *B* | β | *t* | $sr^2$ (unique) |
| Bravo's HMX-I | 0.14 | .15 | 1.29* | .02 |
| Charlie's HMX-I | 0.08 | .10 | 0.84 | .01 |
| Intercept | 4.81 | | | |
| | | | $R$ = | .20 |
| *df* = (2, 79) | *F* = 1.71 | | $R^2$ = | .04 |
| | | | Adjusted $R^2$ = | .02[a] |

| Dependent Variable: Alpha's Overall Satisfaction | | | | |
|---|---|---|---|---|
| Independent Variables | *B* | β | *t* | $sr^2$ (unique) |
| Bravo's HMX-I | 0.08 | .09 | 0.76 | .01 |
| Charlie's HMX-I | 0.10 | .13 | 1.09 | .01 |
| Intercept | 4.92 | | | |
| | | | $R$ = | .18 |
| *df* = (2, 79) | *F* = 1.28 | | $R^2$ = | .03 |
| | | | Adjusted $R^2$ = | .01 |

[a]Wherry (1931).
*$p$ < .10, one-tailed.

Table 8 (cont'd)

| Dependent Variable: Alpha's Satisfaction with Teammates | | | | |
|---|---|---|---|---|
| Independent Variables | *B* | β | *t* | $sr^2$ (unique) |
| Bravo's HMX-II | 0.28 | .29 | 2.78** | .08 |
| Charlie's HMX-II | 0.27 | .24 | 2.31** | .06 |
| Intercept | 2.86 | | | |
| | | | $R$ = | .40 |
| *df* = (2, 79) | $F = 7.74^{\dagger\dagger}$ | | $R^2$ = | .16 |
| | | | Adjusted $R^2$ = | .14 [a] |

| Dependent Variable: Alpha's Overall Satisfaction | | | | |
|---|---|---|---|---|
| Independent Variables | *B* | β | *t* | $sr^2$ (unique) |
| Bravo's HMX-II | 0.27 | .29 | 2.83** | .08 |
| Charlie's HMX-II | 0.30 | .27 | 2.67** | .07 |
| Intercept | 2.67 | | | |
| | | | $R$ = | .43 |
| *df* = (2, 79) | $F = 8.99^{\dagger\dagger}$ | | $R^2$ = | .19 |
| | | | Adjusted $R^2$ = | .16 |

[a]Wherry (1931).

**$p < .05$, one-tailed. $^{\dagger\dagger}p < .05$.

$H_{4b}$: The relationship between HMX quality and satisfaction will be stronger when team members are more interdependent.

The relative size of the association between Bravo and Charlie's HMX and Alpha's satisfaction was tested as in hypothesis 3b. Table 9 compares the relative values with a dependent samples *Z*-test. The hypothesis was not supported for any of the comparisons. Although three of the comparisons met the assumptions of the test (i.e., significant association between the high interdependence HMX and satisfaction and size difference in the predicted direction), the differences were insignificant.

Table 9
Relative Effects of High and Low Interdependence HMX on Satisfaction ($n$ = 82)

| Dependent Variable: Satisfaction with Teammates | | | | |
|---|---|---|---|---|
| | $r_{y,hi}$ | $r_{y,lo}$ | $r_{hi,lo}$ | $Z$ |
| HMX-I | .18 | .15 | .16 | 0.21 |
| HMX-II | .33 | .29 | .19 | 0.30 |

| Dependent Variable: Overall Satisfaction | | | | |
|---|---|---|---|---|
| | $r_{y,hi}$ | $r_{y,lo}$ | $r_{hi,lo}$ | $Z$ |
| HMX-I | .13 | .15 | .32 | -- |
| HMX-II | .33 | .32 | .16 | 0.07 |

Note. The test was a one-tailed *Z*-test for dependent samples (Tabachnick & Fidell, 1989). The cell without a *Z* value did not meet the assumptions of the test (i.e., significant correlation for high interdependence HMX and difference between correlations in the predicted direction).

Although the method of directly testing the relative contribution of high- and low-interdependence HMX in predicting satisfaction showed there were no significant differences in the comparisons made, the uniquenesses were also examined. Table 10

shows the results of hierarchical regressions for two of the comparisons which met the test assumptions. The first comparison shows the slightly greater size of the contribution of high-interdependence HMX-II in predicting satisfaction with teammates. When high-interdependence HMX was entered second, it accounted for 8% of the variance in the dependent variable versus 6% when low-interdependence HMX was entered second. A similar pattern existed for the second comparison, although the size difference was smaller ($\Delta R^2$ for step 2 = .08 vs. .07 for high- and low-interdependence, respectively).

Table 10

Relative Effects of High- and Low-Interdependence HMX-II on Satisfaction ($n = 82$)

| Dependent Variable: Satisfaction With Teammates | | | | | |
|---|---|---|---|---|---|
| Step | Independent Variables | *df* | $R^2$ | $\Delta R^2$ | $\Delta F$ |
| 1 | High Interdependence HMX-II | 1, 80 | .11 | .11 | 9.163†† |
| 2 | Low Interdependence HMX-II | 2, 79 | .16 | .06 | 5.32†† |

| Reverse Entry Order | | | | | |
|---|---|---|---|---|---|
| Step | Independent Variables | *df* | $R^2$ | $\Delta R^2$ | $\Delta F$ |
| 1 | Low Interdependence HMX-I | 1, 80 | .08 | .08 | 7.14†† |
| 2 | High Interdependence HMX-I | 2, 79 | .16 | .08 | 7.74†† |

| Dependent Variable: Overall Satisfaction | | | | | |
|---|---|---|---|---|---|
| Step | Independent Variables | *df* | $R^2$ | $\Delta R^2$ | $\Delta F$ |
| 1 | High Interdependence HMX-II | 1, 80 | .11 | .11 | 10.10†† |
| 2 | Low Interdependence HMX-II | 2, 79 | .19 | .07 | 7.11†† |

| Reverse Entry Order | | | | | |
|---|---|---|---|---|---|
| Step | Independent Variables | *df* | $R^2$ | $\Delta R^2$ | $\Delta F$ |
| 1 | Low Interdependence HMX-I | 1, 80 | .10 | .10 | 9.15†† |
| 2 | High Interdependence HMX-I | 2, 79 | .19 | .08 | 8.03†† |

††$p < .05$.

$H_5$: Members who perceive they have a better HMX relationship with another dyad member will communicate more effectively with the other member.

To determine whether hypothesis 5 was supported, the two measures of Bravo's communication effectiveness with Alpha were regressed on the first and second measures of Bravo's HMX toward Alpha. The first measure of communication effectiveness was formed from Alpha's ratings of Bravo's communication effectiveness. Thus, ratings from different sources (Alpha and Bravo) were compared, eliminating the possibility of same source method effects. The second measure was Alpha's average decision time. Recall that Alpha could not make a decision until Bravo provided the required target information. Once the information was provided, the decision consisted of simply choosing the category which matched the information provided by Bravo. Thus, Bravo's latency in passing information to Alpha determined, in large part, how quickly Alpha could make decisions.

The beta weights for Bravo's HMX quality were tested with directional *t*-tests against the following hypotheses. $H_o$: $\beta_1 = 0$; $H_a$: $\beta_1 > 0$, where $\beta_1$ was the weight predicting Alpha's ratings of Bravo's communication effectiveness. $H_o$: $\beta_2 = 0$; $H_a$: $\beta_2 < 0$, where $\beta_2$ was the weight predicting the average decision time. This weight was predicted to be negative because a longer average time indicated less effective communication. The results of the four regressions are shown in Table 11.

Hypothesis 5 was supported for three of the four comparisons. Bravo's initial and final relationship quality with team member Alpha significantly predicted Bravo's rated communication effectiveness. As hypothesized, the beta weights in both cases were

positive and significant at the .10 and .05 levels, respectively. The effect size for HMX-I was small ($R^2$ = .02), while the effect for HMX-II was of moderate size ($R^2$ = .07).

The third significant regression, which predicted Alpha's average decision time from Bravo's terminal ratings of relationship quality with Alpha, showed that a small, albeit significant, portion of the variance in communication effectiveness was accounted for by relationship quality ($R^2$ = .03). In this case, the beta weight was negative, as predicted, indicating higher levels of relationship quality were associated with shorter decision time.

Table 11
Regression of Communication Effectiveness on HMX ($n$ = 82)

| Dependent Variable: Rated Communication Effectiveness | | | | |
|---|---|---|---|---|
| Independent Variable | *B* | β | *t* | $sr^2$ (unique) |
| Bravo's HMX-I w/Alpha | 0.13 | .15 | 1.40* | .02 |
| Intercept | 5.21 | | | |
| | | | $R$ = | .15 |
| *df* = (1, 80) | $F$ = 1.96 | | $R^2$ = | .02 |
| | | | Adjusted $R^2$ = | .01[a] |

| Dependent Variable: Rated Communication Effectiveness | | | | |
|---|---|---|---|---|
| Independent Variable | *B* | β | *t* | $sr^2$ (unique) |
| Bravo's HMX-II w/Alpha | 0.23 | .26 | 2.38** | .07 |
| Intercept | 4.59 | | | |
| | | | $R$ = | .26 |
| *df* = (1, 80) | $F$ = 5.67†† | | $R^2$ = | .07 |
| | | | Adjusted $R^2$ = | .05 |

| Dependent Variable: Average Decision Time | | | | |
|---|---|---|---|---|
| Independent Variable | *B* | β | *t* | $sr^2$ (unique) |
| Bravo's HMX-I w/Alpha | -0.07 | -.01 | -0.08 | .00 |
| Intercept | 25.82 | | | |
| | | | $R$ = | .01 |
| *df* = (1, 80) | $F$ = 0.01 | | $R^2$ = | .00 |
| | | | Adjusted $R^2$ = | .00 |

| Dependent Variable: Average Decision Time | | | | |
|---|---|---|---|---|
| Independent Variable | *B* | β | *t* | $sr^2$ (unique) |
| Bravo's HMX-II w/Alpha | -1.44 | -.17 | 1.54* | .03 |
| Intercept | 33.57 | | | |
| | | | $R$ = | .17 |
| *df* = (1, 80) | $F$ = 2.37 | | $R^2$ = | .03 |
| | | | Adjusted $R^2$ = | .02 |

[a]Wherry (1931).
*$p$ < .10, one-tailed. **$p$ < .05, one-tailed. ††$p$ < .05.

$H_6$: Communication effectiveness will have a positive effect on member performance.

To assess support for this hypothesis, three linear regression equations were constructed in which rated communication effectiveness and average decision time were entered simultaneously to predict Alpha's individual simulation performance measures (i.e., the number of individual decisions, the number of incorrect decision, and the proportion of correct decisions). The hypotheses took the following form: $H_o$: $R^2 = 0$; $H_a$: $R^2 > 0$. Table 12 contains the results of the regressions of the performance measures on communication effectiveness.

Table 12 shows the hypothesis was strongly supported. Ratings of Bravo's communication effectiveness and Alpha's average decision time predicted a significant amount of variance in all three of the performance measures for team member Alpha. In addition, the amount of performance variance associated with communication effectiveness was quite large. Communication effectiveness predicted 58% of the variance in the number of decisions made by Alpha and 32% of the variance in the proportion of decisions Alpha made correctly. Although communication effectiveness did predict the number of decisions Alpha made incorrectly, the amount of variance predicted was much smaller (i.e., 10%) than for the other performance measures.

It is useful to compare the sum of the uniquenesses to the total performance variance predicted. In each case, the sum of the uniquenesses for the two predictors nearly equaled the total variance predicted, indicating the two measures of communication

effectiveness were associated with nearly separate portions of the variance in the performance measures.

It is also interesting to note the relative size differences in unique contributions to prediction the two independent variables made across the three performance measures. As one would expect, average decision time strongly predicted the total number of decisions made, uniquely accounting for 53% of the variance for this measure. On the other hand, rated communication effectiveness accounted for only 4% of the unique variance in the number of decisions made. However, the relative unique contributions of the two predictors was reversed when the criterion was the number of incorrect decisions. For this performance measure, rated communication effectiveness accounted for more than twice the amount of unique variance (7%) than did average decision time (3%).

Table 12

Regression of Individual Performance on Communication Effectiveness ($n$ = 82)

| Dependent Variable: Number of Decisions | | | | |
|---|---|---|---|---|
| Independent Variables | *B* | β | *t* | $sr^2$ (unique) |
| Rated Comm. Effect. | 2.68 | .21 | 2.86** | .04 |
| Average Decision Time | -1.00 | -.73 | -10.05** | .53 |
| Intercept | 54.05 | | | |
| | | | $R$ = | .76 |
| *df* = (2, 79) | $F = 59.30^{\dagger\dagger}$ | | $R^2$ = | .58 |
| | | | Adjusted $R^2$ = | .57[a] |

| Dependent Variable: Number of Incorrect Decisions | | | | |
|---|---|---|---|---|
| Independent Variables | *B* | β | *t* | $sr^2$ (unique) |
| Rated Comm. Effect. | -1.25 | -.26 | -2.48** | .07 |
| Average Decision Time | 0.09 | .18 | 1.68** | .03 |
| Intercept | 9.73 | | | |
| | | | $R$ = | .32 |
| *df* = (2, 79) | $F = 4.58^{\dagger\dagger}$ | | $R^2$ = | .10 |
| | | | Adjusted $R^2$ = | .08 |

| Dependent Variable: Proportion of Correct Decisions | | | | |
|---|---|---|---|---|
| Independent Variables | *B* | β | *t* | $sr^2$ (unique) |
| Rated Comm. Effect. | 0.04 | .34 | 3.65** | .11 |
| Average Decision Time | -0.01 | -.45 | -4.83** | .20 |
| Intercept | 0.79 | | | |
| | | | $R$ = | .57 |
| *df* = (2, 79) | $F = 18.76^{\dagger\dagger}$ | | $R^2$ = | .32 |
| | | | Adjusted $R^2$ = | .30 |

[a]Wherry (1931).

**$p < .05$, one-tailed. $^{\dagger\dagger}p < .05$.

$H_7$: Communication effectiveness will have a positive effect on member satisfaction.

The interdependence relationships which existed among the team members caused the performance of Alpha to depend, in part, on Bravo's communication effectiveness. Satisfaction was hypothesized to be especially sensitive to the facilitation or inhibition of one's job performance resulting from another member's effective or ineffective communication. To test the hypothesis, two linear regression equations were constructed in which Bravo's communication effectiveness measures predicted Alpha's overall satisfaction and satisfaction with teammates. The two measures of communication satisfaction were entered in the regression simultaneously. Although the satisfaction and communication effectiveness ratings were both gathered from team member Alpha, the inclusion of the average decision time index of communication effectiveness avoided predicting satisfaction solely based on ratings from the same source. The hypotheses took the following form: $H_o$: $R^2 = 0$; $H_a$: $R^2 > 0$.

The results of the regression analyses strongly supported the prediction that a teammate's communication effectiveness would predict a focal member's satisfaction (Table 13). The proportion of satisfaction variance explained was quite large for both satisfaction scores (45% and 44%, respectively for satisfaction with teammates and overall satisfaction). Although rated communication effectiveness accounted for the greatest proportion of unique variance in both regressions, average decision time also predicted a considerable amount of unique satisfaction variance (10% and 12%, respectively for satisfaction with teammates and overall satisfaction).

Table 13
Regression of Satisfaction on Communication Effectiveness ($n = 82$)

| Dependent Variable: Satisfaction with Teammates | | | | |
|---|---|---|---|---|
| Independent Variables | *B* | β | *t* | $sr^2$ (unique) |
| Rated Comm. Effect. | 0.62 | .59 | 7.07** | .34 |
| Average Decision Time | -0.04 | -.32 | -3.80** | .10 |
| Intercept | 3.14 | | | |
| | | | $R$ = | .67 |
| $df = (2, 79)$ | $F = 32.93^{\dagger\dagger}$ | | $R^2$ = | .45 |
| | | | Adjusted $R^2$ = | .44[a] |

| Dependent Variable: Overall Satisfaction | | | | |
|---|---|---|---|---|
| Independent Variables | *B* | β | *t* | $sr^2$ (unique) |
| Rated Comm. Effect. | 0.57 | .56 | 6.65** | .31 |
| Average Decision Time | -0.04 | -.35 | -4.17** | .12 |
| Intercept | 3.43 | | | |
| | | | $R$ = | .67 |
| $df = (2, 79)$ | $F = 31.55^{\dagger\dagger}$ | | $R^2$ = | .44 |
| | | | Adjusted $R^2$ = | .43 |

[a]Wherry (1931).
**$p < .05$, one-tailed. $^{\dagger\dagger}p < .05$.

$H_8$: Team members who communicate more effectively will have more similar coordination cognitions.

For hypothesis 8, the similarity of Alpha and Bravo's coordination cognitions were regressed onto Alpha and Bravo's communication effectiveness scores and Alpha's average decision time. The difference between Alpha and Bravo's score on the coordination cognitions scale served as the index of similarity. Because the index was not reverse scored and actually indicated dissimilarity, the beta weights were predicted to be negative for rated communication effectiveness and positive for average decision time. The beta weights for the three independent variables were tested with directional *t*-tests against the following hypotheses. $H_o$: $\beta_1 = 0$; $H_a$: $\beta_1 > 0$. Table 14 contains the results of these tests.

Hypothesis 8 received some support but the effect size was very small and some of the results were opposite the predicted direction. Alpha's communication effectiveness, as rated by Bravo, predicted the similarity of the coordination cognitions of the two team members, although the amount of unique variance predicted was only 1%. However, Bravo's communication effectiveness, as rated by Alpha, had an unexpected, negative effect on coordination cognition similarity and uniquely accounted for 6% of the criterion variance. Thus, the higher Alpha rated Bravo's communication effectiveness, the more dissimilar were the coordination cognitions of the two team members. The higher Bravo rated Alpha's effectiveness, the more similar were their coordination cognitions. Alpha's average decision time had no effect on the similarity of coordination cognitions. In

addition, the total amount of coordination similarity variance predicted was not significant ($R^2 = .07$, $F = 2.06$).

Table 14
Regression of Coordination Similarity on Communication Effectiveness ($n = 82$)

| Dependent Variable: Similarity of Coordination Cognitions | | | | |
|---|---|---|---|---|
| Independent Variables | *B* | β | *t* | $sr^2$ (unique) |
| Alpha's Comm. Eff. | -0.15 | -.16 | -1.36* | .01 |
| Bravo's Comm. Eff. | 0.30 | .25 | 2.24[a] | .06 |
| Average Decision Time | -0.00 | -.04 | -0.31 | .00 |
| Intercept | -0.63 | | | |
| | | | $R =$ | .27 |
| *df* = (3, 78) | $F = 2.06$ | | $R^2 =$ | .07 |
| | | | Adjusted $R^2 =$ | .04[b] |

[a]Although significant with a one-sided test, the effect was opposite the predicted direction. [b]Wherry (1931).
*$p < .10$.

H9: Shared coordination cognitions will increase individual performance.

To assess support for hypothesis nine, three regression equations were constructed in which the similarity of Alpha and Bravo's coordination cognitions predicted Alpha's simulation performance (i.e., the number of individual decisions, the number of incorrect decisions, and the proportion of correct decisions). The beta weights for coordination cognition similarity were tested with a directional *t*-test against the following hypotheses. $H_o$: $\beta_1 = 0$; $H_a$: $\beta_1 < 0$ for the number of decisions; $H_a$: $\beta_1 > 0$ for the number of incorrect decisions, and $H_a$: $\beta_1 < 0$ for the proportion of correct decisions. Table 15 presents the results of the regression analyses.

Hypothesis nine was supported for two of the three performance measures. The similarity of coordination cognitions predicted both the number of incorrect decisions and the proportion of correct decisions. The beta weight for the number of incorrect decisions was positive and significant and accounted for 5% of the variance in performance. As predicted, the beta weight for the proportion of correct decisions was negative and significant, although slightly less variance (4%) was explained.

Table 15

Regression of Individual Performance on the Coordination Similarity ($n = 82$)

| Dependent Variable: Number of Decisions | | | | |
|---|---|---|---|---|
| Independent Variable | *B* | β | *t* | $sr^2$ (unique) |
| Similarity of Coordination Cognitions | -0.69 | -.07 | -0.59 | .00 |
| Intercept | 44.65 | | | |
| | | | $R$ = | .07 |
| $df$ = (1, 80) | $F$ = 0.34 | | $R^2$ = | .00 |
| | | | Adjusted $R^2$ = | .00[a] |

| Dependent Variable: Number of Incorrect Decisions | | | | |
|---|---|---|---|---|
| Independent Variable | *B* | β | *t* | $sr^2$ (unique) |
| Similarity of Coordination Cognitions | 0.88 | .23 | 2.07** | .05 |
| Intercept | 4.48 | | | |
| | | | $R$ = | .23 |
| $df$ = (1, 80) | $F$ = 4.30†† | | $R^2$ = | .05 |
| | | | Adjusted $R^2$ = | .04 |

| Dependent Variable: Proportion of Correct Decisions | | | | |
|---|---|---|---|---|
| Independent Variable | *B* | β | *t* | $sr^2$ (unique) |
| Similarity of Coordination Cognitions | -0.02 | -.19 | -1.73** | .04 |
| Intercept | 0.89 | | | |
| | | | $R$ = | .19 |
| $df$ = (1, 80) | $F$ = 3.01† | | $R^2$ = | .04 |
| | | | Adjusted $R^2$ = | .02 |

[a]Wherry (1931).

**$p < .05$, one-tailed. †$p < .10$. ††$p < .05$.

$H_{10a}$: The relationship between HMX quality and team performance will be positive.

Hypothesis 10a predicted a relationship between HMX quality and team performance. In this experiment, 12 measures of relationship quality (six initial and six final) were gathered. The measures assessed the perceptions of each team member of the quality of their relationship with their teammates. The hypothesis was assessed by constructing six linear regressions, three in which the initial HMX measures served as the independent variables and three for the final measures relationship quality. In those two sets of equations, the three team performance (i.e., the number of decisions, the number of incorrect decisions, and the proportion of correct decisions) measures were regressed on the six HMX measures. The six predictors were entered simultaneously and the proportion of variance in team performance explained was assessed by the $F$-test. The hypotheses took the following form: $H_o$: $R^2 = 0$; $H_a$: $R^2 > 0$. Table 16 provides the results of the analyses.

The initial HMX measures had no effect on any of the performance indices. Although several of the individual beta weights were significant, the total amount of variance explained was not. The results for the final HMX measure were more supportive of the hypothesis. Significant portions of the variance of two of the three team performance measures were predicted by relationship quality among team members. Thirty eight percent of the variance in the number of targets incorrectly engaged by the team and 42% of the variance in the proportion of targets correctly engaged were predicted by relationship quality.

Table 16
The Effects of HMX on Team Performance

| Dependent Variable: Number of Targets Correctly Engaged | | | | |
|---|---|---|---|---|
| Independent Variables HMX-I | *B* | β | *t* | $sr^2$ (unique) |
| Alpha → Bravo | 0.29 | .02 | 0.14 | .00 |
| Alpha → Charlie | 0.93 | .06 | 0.48 | .00 |
| Bravo → Alpha | -0.73 | -.07 | -0.52 | .00 |
| Bravo → Charlie | -1.47 | -.10 | -0.90 | .01 |
| Charlie → Alpha | 0.64 | .06 | 0.52 | .00 |
| Charlie → Bravo | -1.40 | -.08 | -0.70 | .01 |
| Intercept | 52.22 | | | |
| | | | $R$ = | .16 |
| *df* = (6, 75) | $F$ = 0.39 | | $R^2$ = | .03 |
| | | | Adjusted $R^2$ = | .00[a] |

| Dependent Variable: Number of Targets Incorrectly Engaged | | | | |
|---|---|---|---|---|
| Independent Variables HMX-I | *B* | β | *t* | $sr^2$ (unique) |
| Alpha → Bravo | 0.11 | .26 | 1.97[b] | .04 |
| Alpha → Charlie | -0.02 | -.05 | -0.40 | .00 |
| Bravo → Alpha | -0.08 | -.27 | -2.23** | .06 |
| Bravo → Charlie | 0.05 | .14 | 1.27 | .02 |
| Charlie → Alpha | -0.00 | -.00 | -0.03 | .00 |
| Charlie → Bravo | -0.09 | -.19 | -1.70** | .03 |
| Intercept | 0.94 | | | |
| | | | $R$ = | .36 |
| *df* = (6, 75) | $F$ = 1.80 | | $R^2$ = | .13 |
| | | | Adjusted $R^2$ = | .06 |

Note. The log base 10 transformation of the number of targets incorrectly engaged did not alter the sign of the regression weights, which were predicted to be negative.
[a]Wherry (1931). [b]The beta weight was significant ($p < .05$, one-tailed) but the first order correlation indicated the effect was opposite the predicted direction.
**$p < .05$, one-tailed.

Table 16 (cont'd)

| Dependent Variable: Proportion of Targets Correctly Engaged | | | | |
|---|---|---|---|---|
| Independent Variables HMX-I | *B* | β | *t* | $sr^2$ (unique) |
| Alpha → Bravo | 0.02 | .24 | 1.75[a] | .04 |
| Alpha → Charlie | -0.02 | -.17 | -1.31* | .02 |
| Bravo → Alpha | -0.02 | -.23 | -1.83** | .04 |
| Bravo → Charlie | 0.01 | .08 | 0.73 | .01 |
| Charlie → Alpha | 0.00 | .01 | 0.01 | .00 |
| Charlie → Bravo | -0.00 | -.05 | -0.39 | .00 |
| Intercept | 0.09 | | | |
| | | | $R$ = | .28 |
| *df* = (6, 75) | *F* = 1.05 | | $R^2$ = | .08 |
| | | | Adjusted $R^2$ = | .00[b] |

| Dependent Variable: Number of Targets Engaged | | | | |
|---|---|---|---|---|
| Independent Variables HMX-II | *B* | β | *t* | $sr^2$ (unique) |
| Alpha → Bravo | 2.18 | .19 | 1.25 | .02 |
| Alpha → Charlie | -1.59 | -.14 | -1.01 | .01 |
| Bravo → Alpha | 2.16 | .18 | 1.22 | .02 |
| Bravo → Charlie | -0.35 | -.03 | -0.19 | .00 |
| Charlie → Alpha | 1.97 | .14 | 0.83 | .01 |
| Charlie → Bravo | 0.96 | .07 | 0.42 | .00 |
| Intercept | 12.72 | | | |
| | | | $R$ = | .34 |
| *df* = (6, 75) | *F* = 1.63 | | $R^2$ = | .12 |
| | | | Adjusted $R^2$ = | .04 |

Note. The reversal and log base 10 transformation of the proportion of targets correctly engaged reversed the sign of the regression weights, which were predicted to be negative.

[a]The beta weight was significant ($p < .05$, one-tailed) but the first order correlation indicated the effect was opposite the predicted direction. [b]Wherry (1931).

*$p < .10$, one-tailed. **$p < .05$, one-tailed.

Table 16 (cont'd)

| Dependent Variable: Number of Targets Incorrectly Engaged | | | | |
|---|---|---|---|---|
| Independent Variables HMX-II | *B* | β | *t* | $sr^2$ (unique) |
| Alpha → Bravo | 0.00 | .00 | 0.00 | .00 |
| Alpha → Charlie | -0.06 | -.21 | -1.76** | .02 |
| Bravo → Alpha | -0.17 | -.54 | -4.27** | .15 |
| Bravo → Charlie | 0.08 | .24 | 1.97**[a] | .03 |
| Charlie → Alpha | 0.00 | .01 | 0.07 | .00 |
| Charlie → Bravo | -0.11 | -.31 | -2.14** | .04 |
| Intercept | 2.27 | | | |
| | | | $R$ = | .62 |
| *df* = (6, 75) | $F = 7.71^{\dagger\dagger}$ | | $R^2$ = | .38 |
| | | | Adjusted $R^2$ = | .33[b] |

| Dependent Variable: Proportion of Targets Correctly Engaged | | | | |
|---|---|---|---|---|
| Independent Variables HMX-II | *B* | β | *t* | $sr^2$ (unique) |
| Alpha → Bravo | -0.01 | -.12 | -0.96 | .01 |
| Alpha → Charlie | -0.01 | -.13 | -1.14 | .01 |
| Bravo → Alpha | -0.03 | -.50 | -4.07** | .13 |
| Bravo → Charlie | 0.01 | .18 | 1.57*[a] | .02 |
| Charlie → Alpha | -0.01 | -.14 | -1.04 | .01 |
| Charlie → Bravo | -0.01 | -.18 | -1.23 | .01 |
| Intercept | 0.36 | | | |
| | | | $R$ = | .65 |
| *df* = (6, 75) | $F = 8.97^{\dagger\dagger}$ | | $R^2$ = | .42 |
| | | | Adjusted $R^2$ = | .37 |

Note. The log base 10 transformation of the number of targets incorrectly engaged did not alter the sign of the regression weights, which were predicted to be negative. The transformation of the proportion of targets correctly engaged reversed the sign of the regression weights, which were predicted to be negative.
[a]Although the beta was positive, the first order correlation indicated the effect was in the predicted direction, indicating the presence of a suppressor effect.
[b]Wherry (1931).
*$p < .10$, one-tailed. **$p < .05$, one-tailed. $^{\dagger\dagger}p < .05$.

$H_{10b}$: The relationship between HMX and team performance will be stronger for team members who are more interdependent.

The analyses for hypothesis 10b focused on the relative ability of high- and low-interdependence HMX to predict team performance. Rather than testing the difference between individual variables, as was done in $H_{3b}$, this hypothesis tested the difference between sets of independent variables. Alpha's HMX with Bravo and Bravo's HMX with Alpha comprised the high interdependence independent variable set. The low-interdependence set consisted of the four remaining HMX measures (i.e., Alpha → Charlie, Bravo → Charlie, Charlie → Alpha, and Charlie → Bravo). A dependent samples *Z*-test assessed the following hypotheses: $H_o$: $R_{hi} = R_{low}$; $H_a$: $R_{hi} > R_{low}$; where $R_{hi}$ was the multiple correlation of high-interdependence HMX with performance and $R_{low}$ was the multiple correlation of low-interdependence HMX with performance. A test was performed for the relative effects of high- and low-interdependence HMX on each of the three team performance measures. Although four of the six comparisons met the test assumptions (i.e., the multiple correlation for the high-interdependence set was significant and the difference in multiple correlations was in the expected direction), the differences were not significant (Table 17).

Table 17

Relative Effects of High and Low Interdependence HMX on Team Performance ($n$ = 82)

| Dependent Variable: Number of Targets Engaged | | | | |
|---|---|---|---|---|
| | $R_{y,hi}$ | $R_{y,lo}$ | $R_{hi,lo}$ | $Z$ |
| HMX-I | .05 | .15 | -.02 | -- |
| HMX-II | .26 | .25 | .41 | 0.09 |

| Dependent Variable: Number of Targets Incorrectly Engaged | | | | |
|---|---|---|---|---|
| | $R_{y,hi}$ | $R_{y,lo}$ | $R_{hi,lo}$ | $Z$ |
| HMX-I | .26 | .22 | .02 | 0.27 |
| HMX-II | .51 | .47 | .49 | 0.42 |

| Dependent Variable: Proportion of Targets Correctly Engaged | | | | |
|---|---|---|---|---|
| | $R_{y,hi}$ | $R_{y,lo}$ | $R_{hi,lo}$ | $Z$ |
| HMX-I | .21 | .13 | -.06 | -- |
| HMX-II | .56 | .50 | .55 | 0.69 |

Note. The test was a one-tailed $Z$-test for dependent samples (Tabachnick & Fidell, 1989). The cell without a $Z$ value did not meet the test assumptions (i.e., significant $R$ for high interdependence HMX and difference between $R$'s in the predicted direction).

As an additional assessment of hypothesis 10b, the uniquenesses of the high- and low-interdependence sets of HMX variables were assessed with hierarchical regression analysis. In this procedure, the sets of high- and low-interdependence variables were entered in subsequent steps and then their entry order was reversed. The objective of the analyses was to determine the relative proportions of variance unique to each predictor set. Table 18 presents the results of the hierarchical regression analyses for the three team performance measures.

The first hierarchical regression in Table 18 shows that the difference in uniquenesses of the high- and low-interdependence sets for the prediction of the number of targets engaged from the second HMX measure were minimal. Both sets of variables accounted for 5% of the unique variance (i.e., change in variance when entered at the second step). The three remaining comparisons (i.e., first and second HMX predicting the number of targets incorrectly engaged, and the second HMX measure predicting the proportion of targets correctly engaged) were more supportive of the hypothesis. In each of these cases, the amount of unique variance explained by the high-interdependence set of HMX measures was greater than that of the low-interdependence measures. The largest difference occurred for prediction of the proportion of targets correctly engaged from the second HMX measures (17% vs. 10%, respectively).

Table 18
Differential Effects of HMX on Team Performance ($n$ = 82)

| Dependent Variable: Number of Targets Engaged | | | | | |
|---|---|---|---|---|---|
| Step | IV Sets: HMX-II | *df* | $R^2$ | $\Delta R^2$ | $\Delta F$ |
| 1 | High Interdependence HMX | 2, 79 | .07 | .07 | 2.95$^{\dagger}$ |
| 2 | Low Interdependence HMX | 4, 75 | .12 | .05 | 0.97 |

| Reverse Entry Order | | | | | |
|---|---|---|---|---|---|
| Step | IV Sets: HMX-II | *df* | $R^2$ | $\Delta R^2$ | $\Delta F$ |
| 1 | Low Interdependence HMX | 4, 77 | .06 | .06 | 1.32 |
| 2 | High Interdependence HMX | 2, 75 | .12 | .05 | 2.18 |

| Dependent Variable: Number of Targets Incorrectly Engaged | | | | | |
|---|---|---|---|---|---|
| Step | IV Sets: HMX-I | *df* | $R^2$ | $\Delta R^2$ | $\Delta F$ |
| 1 | High Interdependence HMX | 2, 79 | .07 | .07 | 2.98$^{\dagger}$ |
| 2 | Low Interdependence HMX | 4, 75 | .13 | .06 | 1.20 |

| Reverse Entry Order | | | | | |
|---|---|---|---|---|---|
| Step | IV Sets: HMX-I | *df* | $R^2$ | $\Delta R^2$ | $\Delta F$ |
| 1 | Low Interdependence HMX | 4, 77 | .05 | .05 | 0.94 |
| 2 | High Interdependence HMX | 2, 75 | .13 | .08 | 3.42$^{\dagger\dagger}$ |

$^{\dagger}p < .10$. $^{\dagger\dagger}p < .05$.

Table 18 (cont'd)

| Dependent Variable: Number of Targets Incorrectly Engaged | | | | | |
|---|---|---|---|---|---|
| Step | IV Sets: HMX-II | *df* | $R^2$ | $\Delta R^2$ | $\Delta F$ |
| 1 | High Interdependence HMX | 2, 79 | .26 | .26 | 13.56†† |
| 2 | Low Interdependence HMX | 4, 75 | .38 | .13 | 3.82†† |

| Reverse Entry Order | | | | | |
|---|---|---|---|---|---|
| Step | IV Sets: HMX-II | *df* | $R^2$ | $\Delta R^2$ | $\Delta F$ |
| 1 | Low Interdependence HMX | 4, 77 | .22 | .22 | 5.32†† |
| 2 | High Interdependence HMX | 2, 75 | .38 | .16 | 10.00†† |

| Dependent Variable: Proportion of Targets Correctly Engaged | | | | | |
|---|---|---|---|---|---|
| Step | IV Sets: HMX-II | *df* | $R^2$ | $\Delta R^2$ | $\Delta F$ |
| 1 | High Interdependence HMX | 2, 79 | .32 | .32 | 18.18†† |
| 2 | Low Interdependence HMX | 4, 75 | .42 | .10 | 3.31†† |

| Reverse Entry Order | | | | | |
|---|---|---|---|---|---|
| Step | IV Sets: HMX-II | *df* | $R^2$ | $\Delta R^2$ | $\Delta F$ |
| 1 | Low Interdependence HMX | 4, 77 | .25 | .25 | 6.38†† |
| 2 | High Interdependence HMX | 2, 75 | .42 | .17 | 10.88†† |

††$p < .05$.

Summary of Results

The results of the study can be divided into several areas, including scale performance, the effectiveness of the manipulations, and an evaluation of the conceptual model of HMX and its consequents. Results addressing those topics are summarized in this section. The scales created for this study (i.e., HMX, communication effectiveness, coordination cognitions, and satisfaction) performed quite well. When the two items referring to coordination with team member Charlie were removed from the coordination cognitions scale, the impact on the internal consistency of the scale was positive but minimal. All the scales exhibited acceptable internal consistency reliability, which was encouraging, given the exploratory nature of the constructs involved and the scales created to measure them. The performance of the HMX scale was especially encouraging. It's internal consistency reliability ranged from $r = .93$ to .96 across the three team members and two measurements.

A second issue concerning the design of the study was the effectiveness of the manipulations. The results show the manipulations strongly affected team members' perceptions of relationship quality at the first measurement, just before the simulation. However, both manipulations faded over time. Although the perceived similarity manipulation was initially stronger than the performance expectations manipulation, the relative size of the effects was reversed at the end of the simulation. The perceived similarity effect disappeared over the course of the simulation, while the performance expectations manipulation was diminished at the second measurement but effective throughout the course of team member interactions.

Although the manipulations were most effective at the first measurement of relationship quality, the links between relationship quality and its consequents were most visible at the final HMX measurement. After controlling for cognitive ability, relationship quality explained up to an additional 15% of the variance in individual performance. Although the initial HMX measure did not predict team performance, the final HMX measure predicted 38% of the variance in the number of targets the team engaged incorrectly and 42% of the variance in the proportion of targets the team correctly engaged. This scenario was repeated for the effect of HMX on satisfaction. The second HMX measure explained 16% of the variance in satisfaction with teammates and 19% of the variance in overall satisfaction. The initial HMX measure did predict a small portion of the variance in rated communication effectiveness (2%) but, again, the final HMX measure was much more effective. Final HMX predicted significant amounts of variance in rated communication effectiveness (7%) as well as average decision time (3%).

Some of the largest effects in the study were found when the consequences of communication effectiveness were examined. The conceptual model in Figure 1 proposed links between communication effectiveness, individual performance, and satisfaction. These links were strongly supported. Communication effectiveness predicted between 10 and 58% of the variance in individual performance on the simulation. In addition, communication effectiveness accounted for 45% of the variance in satisfaction with teammates and 44% of the variance in overall satisfaction.

The results for shared coordination cognitions were mixed. On the antecedents side, although both measures of rated communication effectiveness significantly predicted

coordination cognition similarity, the larger effect ($R^2$ = .06) was opposite the expected direction and the other was quite small ($R^2$ = .01). The effects of shared cognitions on performance were more consistent. Shared cognitions predicted significant portions of the variance in individual performance for the number of incorrect decisions (5%) and the proportion of correct decisions (4%) and the effects were in the expected directions.

The final issue the hypotheses addressed was the relative strength of the effects of high- and low-interdependence HMX. None of the comparisons showed high-interdependence HMX (either single variables or sets of variables) to be more predictive than low-interdependence HMX. However, scrutiny of the comparisons which met the test assumptions showed the uniquenesses (squared semipartial correlation and squared semipartial multiple correlation) of the high-interdependence HMX variables were usually slightly larger than their low-interdependence counterparts.

## Discussion

The purpose of this study was to manipulate and explore the effects of the dyadic horizontal exchange relationships (HMX) among team members performing a complex, fast-paced, decision making task. To increase the variability in relationship quality among team members, I manipulated the performance expectations and perceived similarity of two team members toward a third team member. The HMX model (Figure 1), depicts the central role I expected HMX to play in the sequence of team member input, process, and output variables. Specifically, I expected HMX to affect communication effectiveness, the similarity of coordination cognitions, performance, and satisfaction. I also hypothesized that higher levels of process interdependence among team members would result in stronger HMX effects.

In the previous section, I described the effects of the manipulations on team member relationship quality and the subsequent effects of HMX and other process variables on individual and team performance and the satisfaction of the focal team member. In this section, I summarize the strengths, key findings, limitations, and theoretical and practical implications of the study.

### Strengths

Two features of the study design increase my confidence in the generalizability of the results. The greatest strength was the TANDEM simulation. During debriefings, participants described TANDEM as being realistic and extremely engaging; many liked the task so much that they were disappointed when the simulation ended. And, even though the time remaining in the simulation was clearly displayed to team members, many team

members were so engaged in the task that they were surprised when the simulation ended. The intrinsically interesting nature of the task and the participants' response to the realism of the setting (e.g., headsets, microphones, subdued lighting, military charts and maps lining the walls, and the use of "call signs" for team member names) contribute to my conclusion that the experiment accurately fostered the phenomenon one might observe in work settings.

My confidence in the results is also strengthened because the study design allowed data to be gathered from multiple team members using rating scales as well as relatively more objective computer-generated data sources. The data also represented measures of input, process, and output factors, such as mental ability, working relationship quality, and performance accuracy, which are obtainable in many applied settings. In most cases, hypothesis antecedents and consequents were gathered from different team members. The simulation provided relatively more objective measures of communication processes and performance. In some cases, the computer generated sources of data provided objective benchmarks, which complemented the ratings. In other cases, the simulation data provided objective measures of performance, which were predicted by rated constructs. For example, the combination of data sources enabled me to predict the simulation-generated performance measures of one team member from the relationship quality ratings of the other two team members.

The prediction of performance from communication effectiveness provides a third example of the generalizability gained from the use of multiple sources. In this case, team member ratings and a process measure generated by the simulation predicted individual

performance. The use of measures from multiple raters, sources, and from multiple points in a model of inputs, processes, and outputs reduced the likelihood that significant results were obtained solely due to method effects, such as the increased correlation between ratings from the same team member. Although those method effects are probably present in the data to some degree, the analyses guarded against them as much as possible. The nature of the task and the various sources of data strengthen my conclusion that the phenomenon observed were reasonable indicators of what one might observe in many applied settings where teams do the work. These settings, from military operations to automobile assembly teams, vary in many respects but they share the basic characteristics of all teams. Just as was required by the simulation, interdependent team members perform differentiated tasks to accomplish a common goal, whether that goal is defending a ship from hostile targets or building a car to exacting tolerances of fit and finish.

Key Findings

The most important findings of the study are those regarding the dyadic horizontal exchange relationships among team members. Those findings are reviewed first, followed by findings for other hypotheses drawn from Figure 1. Although individual and team performance are not the only criteria for judging team effectiveness, they are critical to the organizations that employ team-based work forces. Two hypotheses addressed the relationship between HMX and performance. Hypothesis 3a, which tested the contribution of HMX to individual performance after controlling for general mental ability level was the most stringent test of the importance of relationship quality. The hypothesis addressed the question of whether knowledge of the level of relationship quality is useful

for diagnosing performance problems beyond just selecting the brightest people for the team.

The answer is a resounding, "Yes." HMX predicted between 6 and 15% of the variance in individual performance after partialling ability level. Ability was partialled to separate the influence of the focal member's ability on their performance from the impact that teammates have on the focal member's performance. As hypothesized, other people's perceptions of their relationship quality with a focal team member had significant and large effects on the focal member's performance. The same was true of the impact of HMX on team performance ($H_{10a}$). HMX predicted between 38 and 42% of the variance in team performance. These results clearly demonstrate the importance of the dyadic relationships among peers. The way a team member feels about the quality of their working relationship with a teammate affects how well the teammate performs. At the level of the entire team, performance is also a product of the quality of the working relationships among team members.

Relationship quality was an especially strong predictor of the individual and team outcome variables that measured errors in performance (i.e., number of incorrect decisions and proportion of correct decisions). For example, HMX predicted 42% of the variance in the proportion of targets correctly engaged by the team but did not significantly predict the number of targets the team engaged. For individual performance, relationship quality accounted for 13% of the variance in the number of incorrect decisions but only 6% of the variance in the number of decisions overall. The results suggest individual and team performance can be divided into two aspects which index speed and accuracy and that

relationship quality had the greatest impact on the performance measures which indexed accuracy.

Hackman (1987) suggested team member satisfaction should be considered as an additional criterion of team effectiveness because it affects the future viability of the team. I hypothesized that others' perceptions of their working relationship with a focal team member will affect the focal member's satisfaction because of the way relationship quality affects the way team members treat each other. As predicted, other team members' perceptions of their relationship with a focal team member predicted the focal member's satisfaction with their teammates as well as their overall satisfaction ($H_{4a}$). HMX predicted 16% of the variance in satisfaction with teammates and 19% of the variance in overall satisfaction.

I had expected HMX to have a stronger effect on satisfaction with teammates than on overall satisfaction. The reverse occurred, even though the two satisfaction measures were highly correlated ($r$ = .96). Because the internal consistency reliabilities of the two measures differed only marginally ($r$ = .87 vs. .82 for overall satisfaction and satisfaction with teammates, respectively), it does not appear the increase in reliability of the overall scale accounts for the difference in variance explained. Team member reluctance to express their dissatisfaction with their teammates may have decreased the relationship between HMX and satisfaction with teammates. The components of satisfaction and their relationship to HMX should be further investigated.

Given the strong relationships between HMX and individual and team outcome variables, it is important to investigate the process by which that influence occurred. As in

all teams, the simulation used in this study required team members to rely on each other to perform their individual tasks. In particular, the simulation required team members to exchange information (as opposed to passing the ball on a soccer team). Therefor, communication effectiveness was hypothesized to be a conduit through which the effects of relationship quality would flow.

Two variables were used as indicators of communication effectiveness, including team member ratings and the focal member's decision speed. Decision speed was used as an indicator of communication effectiveness because the focal team member had to wait for information to be passed before they could make an accurate decision. Thus, I expected that relationship quality would impact both the speed with which information was provided to the focal member and the overall evaluation of how effectively the team member communicated. Although the communication requirement was relatively simple (e.g., "Alpha, the initial bearing is 260 degrees."), the exchange process was complicated because team members sometimes failed to insure they were exchanging information about the same target. For example, Alpha may have moved on to target 19 and provide information about target 19 to Bravo, who was still working on target 18. Some teams never recovered from this failure in coordination.

The results supported the overall hypothesis that relationship quality determines communication effectiveness ($H_5$). Examination of the standardized regression weights also showed that HMX affected communication effectiveness ratings and the average decision time generated by the simulation. Although HMX produced smaller effects on communication effectiveness (i.e., 2 - 7% variance) than on satisfaction or performance,

this was the only instance in which the first HMX measurement predicted an indicator of team process or outcomes. The significant relationship between HMX and communication effectiveness links perceptions of relationship quality and team member behavior. The results show the quality of our working relationship with our teammates determines how well we communicate.

It is also important to note that HMX influenced communication, even though communication during the simulation was a strong demand characteristic of the study (i.e., I told teams I wanted them to communicate and perform as well as possible). In addition to being told they should communicate, the simulation provided limited flexibility for accomplishing the task. Team members could not make their decisions without communicating unless they guessed. A different task would have provided team members more latitude in their task performance.

The presence of transaction alternatives (i.e., methods of accomplishing the task which transit alternative paths through the team; Kozlowski et al., 1994) would have allowed team members with low quality relationships to avoid each other even though the most direct means of accomplishing the task would be to for them to interact. One would expect the effects of HMX on communication effectiveness to be magnified when the team task provides for transaction alternatives.

The effect of relationship quality on communication might also be magnified by the criticality of the task. Effective communication and high performance were demand characteristics of the simulation (i.e., I directed team members to communicate and perform as well as possible). One might expect high communication effectiveness

regardless of relationship quality when motivation to perform the task is high (e.g., in military teams when survival is at stake or in assessment center exercises). When the task is less critical or when the team is not expecting a critical situation (e.g., the USS Vincennes incident), teams may fall into habitual routines (Gersick & Hackman, 1990) or individuals may perform at typical rather than maximum levels (Sackett, Zedeck, & Fogi, 1988). These circumstances may allow team members much greater latitude to enact their perceptions of relationship quality and create commensurably larger effects on communication.

Thus, even though the characteristics of the simulation may have limited the degree to which HMX quality manifested effects on the communication process measures, significant effects still emerged. However, the characteristics of the simulation may account for the relatively small proportion of variance in communication effectiveness explained by relationship quality. Despite the smaller effect sizes on communication, the results clearly demonstrate the value of the HMX construct to team members, teams, and organizations that utilize teams. When relationship quality was high, team members communicated better, performed better, and were more satisfied. Furthermore, the effects of relationship quality were not only significant but often sizable.

Beyond the issue of the significance of HMX effects, the pattern of effect sizes on surrounding communication effectiveness is puzzling. The causal order in Figure 1 is from HMX to communication effectiveness and then to performance and satisfaction. However, the combination of small effects of HMX on communication effectiveness ($H_5$), large effects of HMX on performance and satisfaction ($H_4$), and large effects of

communication effectiveness on performance ($H_6$) and satisfaction ($H_7$) are not consistent with a mediating role for communication effectiveness.

Beyond the limiting characteristics of the simulation discussed above, another possible reason for the observed pattern is that the causal sequence depicted in Figure 1 (i.e., HMX to communication effectiveness to performance) is simply wrong. HMX and communication effectiveness may have reciprocal influences or HMX may be a consequence of communication effectiveness. Another possibility is that the indices of communication effectiveness employed were deficient enough to obscure the true strength of the effects of HMX on communication. The present study does not allow these possibilities to be tested and this issue should be considered in future research on HMX.

Another interesting aspect of the results for communication effectiveness is the relative contributions of the ratings and average decision time indices to performance. Because average decision time results from a combination of the focal team member's performance and the speed with which another team member provides information, the large relationship between decision time and the number of decisions made was expected. Similarly, the relatively larger effect of communication effectiveness ratings versus average decision time on the number of incorrect decisions was also expected. The ratings captured actions which would lead to errors in the communication process but average decision time did not. Although those two results were expected, it is difficult to understand why average decision time contributed more to the prediction of the proportion of correct decisions (20% variance) than did the communication effectiveness ratings (10% of the variance in the proportion of correct decisions). This result is

especially vexing because the relative contributions of the ratings and average decision time were reversed for the number of incorrect decisions but the two performance measures were highly correlated ($r$ = -.90). I cannot explain these results and suggest the issue should be addressed by future research.

Hypotheses eight and nine addressed the source of shared knowledge and its effects on performance. The results for hypothesis 8, which predicted a relationship between communication effectiveness and the similarity of team members' coordination cognitions, are difficult to interpret. Alpha and Bravo's ratings of each other's communication effectiveness were significant predictors of coordination cognition similarity but the beta weight for Bravo's communication effectiveness, which was the larger effect, showed the effect was opposite the predicted direction. Examination of the first order correlation between communication effectiveness and the similarity of coordination cognitions confirmed that a suppressor effect was not operating.

Further examination of the correlation matrix revealed that the similarity of Alpha and Bravo's coordination cognitions was significantly related to Alpha's first relationship quality ratings with both Bravo and Charlie but not with any other measure of relationship quality. It was, however, related to several of the individual and team performance measures. Similarity predicted the number of incorrect decisions and the proportion of correct decisions for individual performance ($H_9$). From the correlation table, it was also related to team performance (the number of targets incorrectly engaged by the team and the proportion of targets correctly engaged by the team). So, the results for the effects of coordination similarity followed a pattern much like those for the prediction of

performance from relationship quality. Coordination cognition similarity was a much better indicator of the performance measures which indexed errors in performance than of the speed of task performance.

The failure to find any consistent, interpretable pattern of results for the antecedents of coordination cognition similarity indicate the need for further exploration of the construct and its relationship to communication effectiveness. Additional analytical methods might be explored for the operationalization of similarity, such as using different similarity indices (e.g., the absolute difference or squared difference; Cronbach & Gleser, 1953) or using polynomial regression equations as alternatives to difference scores (e.g., Edwards, 1994; Edwards & Parry, 1993).

The final set of results to be interpreted include those which addressed the differences between the effects of high and low interdependence HMX. Hypotheses 3b, 4b, and 10b addressed the relative effects of HMX on individual performance, satisfaction, and team performance, respectively. There were no differences in the effects of high- and low-interdependence HMX on any of these outcome measures. Examination of the uniquenesses of high- and low-interdependence HMX indicated that, although the differences were small, they were usually in the expected direction.

The failure to find significant differences in the effects of high- and low-interdependence HMX may have been a result of the design. Because the design insured that team members Bravo and Charlie received the same information about Alpha and that Charlie observed the interactions between Alpha and Bravo, it is not surprising the high- and low-interdependence measures showed high multiple correlations. The multiple

correlations between the sets of high- and low-interdependence independent variables were highest for the final HMX measures, ($R$ ranged from .41 to .55). Since the test statistic used to distinguish high- and low-interdependence accounted for the intercorrelation of the predictors or sets of predictors, the high intercorrelations reduced the likelihood of finding a significant difference. Thus, the design fostered high intercorrelations between high- and low-interdependence relationship quality and the intercorrelations may have prevented any differences in high- and low-interdependence effects from emerging.

The uniquenesses of the high- and low-interdependence relationship quality variables were examined using hierarchical regression as an alternative to direct tests of the difference in effect sizes. Although the differences in uniquenesses shown in Table 18 are relatively small, they do support the role interdependence level plays in determining the importance of relationship quality for team performance. A different design, for example one in which the noninterdependent teammate cannot observe the interactions that occur in other dyads, may increase the differences in the effects HMX of differing degrees of interdependence. As a final point about interdependence levels, it is useful to recognize the stringent nature of the analyses for team performance. This test compared the predictive power of two high-interdependence variables against four low-interdependence variables, which creates an extremely high standard for finding a significant difference.

Limitations

Although the simulation and design were major sources of strength for the study, they also imposed some limitations. For example, while initially strong, the manipulations

failed to produce large effects on relationship quality throughout the experiment. Performance expectations and perceived similarity may have had stronger and longer-lasting effects if the manipulations had been designed differently. For example, additional time in each session would allow multiple reinforcements of the manipulations. Team members could be asked to argue controversial topics from a similar or dissimilar perspective to strengthen perceptions of similarity or dissimilarity. In an applied setting, current team members might be told their new teammate comes to them with an outstanding record of high performance (e.g., Eden & Shani, 1982).

An additional limitation of the study is the relatively low power of some of the significance tests, especially the tests for hypotheses 10a and b, which included six independent variables. Although relatively liberal alpha levels were used, the power of hypothesis 10 was still quite low for some of the tests due to the small effect and sample sizes. For example, the effect of the first HMX measures on the number of targets engaged by the team was $R^2 = .03$ (Table 16). The power of the significance test with alpha at .05 was 16% (by interpolation from Table E.2 in Cohen & Cohen, 1983). For the effect of the first HMX measure on the number of targets incorrectly engaged ($R^2 = .13$), the power of the test was 70%.

However, the study design prevents unequivocal statements of causation by the second HMX measure because it was gathered concurrently with satisfaction and after the end of the simulation. HMX is, conceptually, an evaluation of a process of cyclical, dyadic interactions and logically precedes outcome measures, such as performance and satisfaction. The conceptual ordering of HMX and task outcomes justified by construction of the hypotheses but does not insure that participants' second HMX ratings would have predicted performance and satisfaction in a subsequent simulation.

The first HMX measure may have not have influenced the process and outcome measures because team members interacted for only a few minutes before providing the first HMX rating. However, Dockery and Steiner's (1990) results suggest vertical relationships form very quickly (i.e., in the first ten minutes of interaction) and there is no apparent reason to believe the time frame for the formation of horizontal relationships would differ in any way. Other research suggests supervisors are reluctant to differentiate among their subordinates in initial measurements of vertical quality (Graen & Scandura, 1987). However, the strong effects of the manipulations on the first assessment of horizontal relationship quality indicates team members were willing to distinguish their teammates. They may not, however, been willing to act on their initial expectations, essentially giving their teammate a chance to prove themselves.

This issue is critical to the study of horizontal relationship quality because it has theoretical and practical relevance. The current model of HMX places it as an antecedent of team processes and outcomes. Future research must further investigate the causal sequence and seek to determine why the initial measure of relationship quality showed few

predicted relationships, while the second measure of HMX was strongly related to team process and performance measures.

Although they contributed to the strengths of the study, the simulation and participants imposed two final limitations. The first is the generalizability of the simulation. Even though the simulation was realistic and engaging, it does not generalize equally well to all team tasks. The simulation was a complex, decision making task of relatively short duration. The duration of the simulation prevented observation of the long-term relationships found in many work teams. Since we know the tenure of a working relationship affects many aspects of the interactions that take place in the dyad, including the amount of communication and the amount of shared knowledge, a longer observation period may have produced different results. Given the many dimensions along which working relationships develop (Gabarro, 1990), a field setting would have provided the opportunity to observe mature teams in realistic settings.

The simulation also involved few requirements for physical abilities, although I learned that the hearing impaired could not perform the task because the headsets interfered with their hearing aids. It is possible that more physical team tasks, such as team sports or automobile assembly teams, would have produced different results.

The participants, college student volunteers, also limit the generalizability of the results. Although some participants exhibited the high level of motivation one would expect to find in a military team performing a dangerous task, other participants appeared to absent themselves from the study in all but their physical presence. The average mental ability level of college students probably exceeds the level one might find in some

industrial teams but is below the expected level of top-level management teams. Because the composition of a team in terms of the ability level of the team members does affect the expected performance of the team (Tziner & Eden, 1985) the results may differ for teams of different ability compositions.

Extensions

Future research of the horizontal team member exchange construct should focus on three areas. Initial efforts should attempt to address the limitations of this study, which were imposed by the simulation and the participants. A first study might investigate horizontal team member exchange in hierarchical teams in a field setting. This type of setting would provide several advances beyond the current study.

First, a field study would provide the opportunity to investigate the effects of horizontal relationship quality in the presence of vertical relationships. The presence of vertical relationships may reduce the importance of horizontal exchanges but should not eliminate their effects. Second, a field setting would provide the opportunity to study HMX in real teams performing real tasks. There is no substitute for the advantages gained from observing people in their work settings. At the same time, the work setting brings with it a myriad of influences (e.g., family, organizational, economic) which make disentangling the findings of field research much more difficult. A third advantage of studying HMX in a field setting is the opportunity to diversify the type of task studied. The many types of teams available for study, including sports teams, management teams, military teams, and manufacturing teams each entail unique influences, goals, and other characteristics. Each type of team provides opportunities for relationship quality to

manifest its effects in different process measures, such as the ball sharing tendencies of soccer team members or the rework rates of manufacturing teams. Each type of team also provides different outcome measures, which may differ in their sensitivity to relationship quality. Regardless of the type of team selected, a field study of horizontal relationship quality provides many opportunities to extend the current work beyond a brief laboratory task.

The model in Figure 1 should be the second area of focus for future research. In particular, research is needed to clarify the causal ordering of the constructs in the model. An unambiguous demonstration of the ability of horizontal relationship quality to predict communication effectiveness, performance, and satisfaction is required. This research might include multiple measurement waves to determine if the failure of the first HMX measurement in the present study is replicable or a matter of timing (e.g., more than 10 minutes of interaction is required before team members gain a realistic sense of relationship quality). The research should also attempt to clarify the status of communication effectiveness as a mediator between HMX and shared coordination cognitions, performance, and satisfaction. The research might also address the apparent differential effects of HMX on performance measures of speed and accuracy. The speed of performance may be universally insensitive to relationship quality, although a task with more latitude for differences in speed of performance and fewer demand characteristics for speedy performance should be sensitive to HMX in terms of both speed and accuracy.

Future research should also focus on the antecedents and components of horizontal relationship quality. Dienesch and Liden (1986) proposed a three component

structure for vertical relationships based on the belief that trust, affect, and contribution to the relationship are three aspects which are available to leaders and subordinates alike. The present study attempted to create differentiated relationships by manipulating the affect and expected contribution components of team member relations. Although the manipulation was initially successful in determining relationship quality, the effect decreased substantially over the brief period of the simulation. Future research should investigate the impact of trust (the third aspect of relationship quality) on team member interactions. Increased understanding of the potential for creating enduring increases in relationship quality through intervention is also necessary. Finally, it is possible that additional relationship quality components exist beyond the three proposed by Dienesch and Liden (1980) or that the components of vertical and horizontal relationships differ because of the differences in the symmetry of vertical and horizontal relationships. These possibilities are extremely important for insuring our understanding of team member interactions is used to improve the quality of those interactions and the overall performance of individuals and teams.

Conclusion

With the resurgent interest in groups and teams, it is somewhat surprising that no current theoretical perspective focuses on the working relationships among team members. This study explored the effects of horizontal relationship quality and provided a theoretical framework for understanding those interactions. The study confirmed the importance of the dyadic interactions among team members to several measures of team effectiveness, including communication, satisfaction, and performance indices.

The strong influence of relationship quality on the occurrence of performance errors suggests the construct has great potential for application in teams in which error-free performance is critical. Aircrews, naval combat teams, and aerospace maintenance teams face situations daily in which error-free performance can mean the difference between life and death. Although manufacturing teams do not typically face the same consequences for committing errors, their errors can be extremely costly in terms of lost production and damaged material. Although much remains to be understood about horizontal working relationships, research efforts which address the antecedents, consequents, and practical applications of HMX are likely to produce more satisfied, more productive, and safer team members.

# APPENDIX A

## Manipulation Script and Team Member Feedback Forms

**Briefing provided prior to test administration**. You are participating in the TAS experiment. In this experiment, you are designated as team members Alpha, Bravo, and Charlie. Remember these names as you will need to use them throughout the experiment. The tests you are about to take will help us understand how ability and personality affect team performance. The first test is a timed, 12-minute measure of ability. The test helps us predict who will perform very well or very poorly on the simulation. In general we have found that people who make a high score on this test do pretty well on the simulation. The second is a questionnaire which assesses team-related personality and attitude factors. We think the scores on this questionnaire will help us predict which team members are more similar to each other and how well they will work together on a team. Since the accuracy of these tests depends on your honesty and effort, please do your best to answer the questions as well as you can. After you complete the tests, I will record your scores on this team feedback form. As you can see, we divide the ability scores into several categories, which relate to how well people do on the simulation. We also categorize the similarity of your scores on the Team Personality and Attitudes Test into these five dimensions. If you take a look at them now, you will see how they are related to teamwork.

**Briefing provided at time of the feedback provided.** Here are the scores for you and your teammates on the ability and team personality and attitudes tests. Please take two minutes to review these scores and remember as much about them as you are able. At the end of the experiment, you will be asked to remember as many of the scores as you can.

Feedback form given to Alpha - all conditions

# Team Ability and Personality Match Form

| Ability Category | Alpha | Bravo | Charlie |
|---|---|---|---|
| Very High | | | |
| Above Average | 21 | 19 | 20 |
| Average | | | |
| Below Average | | | |
| Very Low | | | |

| Personality and Team Attitudes Similarity | Alpha - Bravo | Alpha - Charlie | Bravo - Charlie |
|---|---|---|---|
| Self-Reliance: The degree to which one values personal independence over teamwork | High Match | Unclear | Unclear |
| Competitiveness: The degree to which one values competitiveness over cooperation | Partial Match | High Match | Partial Match |
| Individual Effort: The degree to which one values working alone over working as a team | Partial Match | Partial Match | Partial Match |
| Helpfulness: The degree to which one values subordination of personal needs to team needs | Unclear | Unclear | Partial Match |
| Success Orientation: The degree to which one values individual over team success | High Mismatch | Partial Match | Partial Match |

Feedback form given to Bravo - high expectations, high similarity condition

# Team Ability and Personality Match Form

| Ability Category | Alpha | Bravo | Charlie |
|---|---|---|---|
| Very High | 26 | | |
| Above Average | | 19 | 20 |
| Average | | | |
| Below Average | | | |
| Very Low | | | |

| Personality and Team Attitudes Similarity | Alpha - Bravo | Alpha - Charlie | Bravo - Charlie |
|---|---|---|---|
| Self-Reliance: The degree to which one values personal independence over teamwork | High Match | Partial Match | Unclear |
| Competitiveness: The degree to which one values competitiveness over cooperation | High Match | Unclear | Partial Mismatch |
| Individual Effort: The degree to which one values working alone over working as a team | High Match | Partial Match | Partial Match |
| Helpfulness: The degree to which one values subordination of personal needs to team needs | High Match | Partial Match | Partial Match |
| Success Orientation: The degree to which one values individual over team success | High Match | Partial Match | Partial Match |

Feedback form given to Bravo - high expectations, low similarity condition

# Team Ability and Personality Match Form

| Ability Category | Alpha | Bravo | Charlie |
|---|---|---|---|
| Very High | 26 | | |
| Above Average | | 19 | 20 |
| Average | | | |
| Below Average | | | |
| Very Low | | | |

| Personality and Team Attitudes Similarity | Alpha - Bravo | Alpha - Charlie | Bravo - Charlie |
|---|---|---|---|
| Self-Reliance: The degree to which one values personal independence over teamwork | High Mismatch | Partial Match | High Mismatch |
| Competitiveness: The degree to which one values competitiveness over cooperation | High Mismatch | Unclear | Partial Match |
| Individual Effort: The degree to which one values working alone over working as a team | High Mismatch | Partial Match | Partial Match |
| Helpfulness: The degree to which one values subordination of personal needs to team needs | High Mismatch | High Match | Partial Match |
| Success Orientation: The degree to which one values individual over team success | High Mismatch | Unclear | Partial Match |

Feedback form given to Bravo - low expectations, high similarity condition

# Team Ability and Personality Match Form

| Ability Category | Alpha | Bravo | Charlie |
|---|---|---|---|
| Very High | | | |
| Above Average | | 19 | 20 |
| Average | | | |
| Below Average | 13 | | |
| Very Low | | | |

| Personality and Team Attitudes Similarity | Alpha - Bravo | Alpha - Charlie | Bravo - Charlie |
|---|---|---|---|
| Self-Reliance: The degree to which one values personal independence over teamwork | High Match | Partial Match | Unclear |
| Competitiveness: The degree to which one values competitiveness over cooperation | High Match | Unclear | Partial Mismatch |
| Individual Effort: The degree to which one values working alone over working as a team | High Match | Partial Match | Partial Match |
| Helpfulness: The degree to which one values subordination of personal needs to team needs | High Match | Partial Mismatch | Partial Match |
| Success Orientation: The degree to which one values individual over team success | High Match | Partial Match | Partial Match |

Feedback form given to Bravo - low expectations, low similarity condition

# Team Ability and Personality Match Form

| Ability Category | Alpha | Bravo | Charlie |
|---|---|---|---|
| Very High | | | |
| Above Average | | 19 | 20 |
| Average | | | |
| Below Average | 13 | | |
| Very Low | | | |

| Personality and Team Attitudes Similarity | Alpha - Bravo | Alpha - Charlie | Bravo - Charlie |
|---|---|---|---|
| Self-Reliance: The degree to which one values personal independence over teamwork | High Mismatch | Partial Match | Unclear |
| Competitiveness: The degree to which one values competitiveness over cooperation | High Mismatch | Unclear | Partial Mismatch |
| Individual Effort: The degree to which one values working alone over working as a team | High Mismatch | Partial Match | Partial Match |
| Helpfulness: The degree to which one values subordination of personal needs to team needs | High Mismatch | Partial Match | Partial Match |
| Success Orientation: The degree to which one values individual over team success | High Mismatch | Partial Match | Partial Match |

Feedback form given to Charlie - high expectations, high similarity condition

# Team Ability and Personality Match Form

| Ability Category | Alpha | Bravo | Charlie |
|---|---|---|---|
| Very High | 26 | | |
| Above Average | | 19 | 20 |
| Average | | | |
| Below Average | | | |
| Very Low | | | |

| Personality and Team Attitudes Similarity | Alpha - Bravo | Alpha - Charlie | Bravo - Charlie |
|---|---|---|---|
| Self-Reliance: The degree to which one values personal independence over teamwork | Partial Match | High Match | Unclear |
| Competitiveness: The degree to which one values competitiveness over cooperation | Unclear | High Match | Partial Mismatch |
| Individual Effort: The degree to which one values working alone over working as a team | Partial Match | High Match | Partial Match |
| Helpfulness: The degree to which one values subordination of personal needs to team needs | Partial Mismatch | High Match | Partial Match |
| Success Orientation: The degree to which one values individual over team success | Partial Match | High Match | Partial Match |

Feedback form given to Charlie - high expectations, low similarity condition

# Team Ability and Personality Match Form

| Ability Category | Alpha | Bravo | Charlie |
|---|---|---|---|
| Very High | 26 | | |
| Above Average | | 19 | 20 |
| Average | | | |
| Below Average | | | |
| Very Low | | | |

| Personality and Team Attitudes Similarity | Alpha - Bravo | Alpha - Charlie | Bravo - Charlie |
|---|---|---|---|
| Self-Reliance: The degree to which one values personal independence over teamwork | Partial Match | High Mismatch | Unclear |
| Competitiveness: The degree to which one values competitiveness over cooperation | Unclear | High Mismatch | Partial Mismatch |
| Individual Effort: The degree to which one values working alone over working as a team | Partial Match | High Mismatch | Partial Match |
| Helpfulness: The degree to which one values subordination of personal needs to team needs | Partial Match | High Mismatch | Partial Match |
| Success Orientation: The degree to which one values individual over team success | Partial Match | High Mismatch | Partial Match |

Feedback form given to Charlie - low expectations, high similarity condition

# Team Ability and Personality Match Form

| Ability Category | Alpha | Bravo | Charlie |
|---|---|---|---|
| Very High | | | |
| Above Average | | 19 | 20 |
| Average | | | |
| Below Average | 13 | | |
| Very Low | | | |

| Personality and Team Attitudes Similarity | Alpha - Bravo | Alpha - Charlie | Bravo - Charlie |
|---|---|---|---|
| Self-Reliance: The degree to which one values personal independence over teamwork | Partial Match | High Match | Unclear |
| Competitiveness: The degree to which one values competitiveness over cooperation | Unclear | High Match | Partial Mismatch |
| Individual Effort: The degree to which one values working alone over working as a team | Partial Match | High Match | Partial Match |
| Helpfulness: The degree to which one values subordination of personal needs to team needs | Partial Mismatch | High Match | Partial Match |
| Success Orientation: The degree to which one values individual over team success | Partial Match | High Match | Partial Match |

Feedback form given to Charlie - low expectations, low similarity condition

# Team Ability and Personality Match Form

| Ability Category | Alpha | Bravo | Charlie |
|---|---|---|---|
| Very High | | | |
| Above Average | | 19 | 20 |
| Average | | | |
| Below Average | 13 | | |
| Very Low | | | |

| Personality and Team Attitudes Similarity | Alpha - Bravo | Alpha - Charlie | Bravo - Charlie |
|---|---|---|---|
| Self-Reliance: The degree to which one values personal independence over teamwork | Partial Match | High Mismatch | Unclear |
| Competitiveness: The degree to which one values competitiveness over cooperation | Unclear | High Mismatch | Partial Mismatch |
| Individual Effort: The degree to which one values working alone over working as a team | Partial Match | High Mismatch | Partial Match |
| Helpfulness: The degree to which one values subordination of personal needs to team needs | Partial Match | High Mismatch | Partial Match |
| Success Orientation: The degree to which one values individual over team success | Partial Match | High Mismatch | Partial Match |

APPENDIX B

Personality and Team Attitudes Scale for All Team Members

Sometimes it may be best when people put the interests of groups ahead of personal desires. At other times it may be best for people to concentrate on what is best for them personally. Using the scale below, indicate how much you **Agree** with the following statements. Mark your responses on the scantron sheet.

1. **Strongly Disagree**
2. **Disagree**
3. **Slightly Disagree**
4. **Neither Agree Nor Disagree**
5. **Slightly Agree**
6. **Agree**
7. **Strongly Agree**

1. Only those who depend on themselves get ahead in life.
2. To be superior, a person must stand alone.
3. If you want something done right, you've got to do it yourself.
4. What happens to me is my own doing.
5. In the long run, the only person you can count on is yourself.
6. Winning is everything.
7. I feel that winning is important in both work and games.

8. Success is the most important thing in life.

9. It annoys me when other people perform better than I do.

10. Doing your best isn't enough; it is important to win.

11. I prefer to work with others in a group rather than working alone.

12. Given the choice, I would rather do a job where I can work alone rather than doing a job where I have to work with others in a group.

13. Working with a group is better than working alone.

14. People should be made aware that if they are going to be part of a group then they are sometimes going to have to do things they don't want to do.

15. People who belong to a group should realize that they're not always going to get what they personally want.

16. People in a group should realize that they sometimes are going to have to make sacrifices for the sake of the group as a whole.

17. People in a group should be willing to make sacrifices for the sake of the group's well-being.

18. A group is more productive when its members do what they want to do rather than what the group wants them to do.

19. A group is most efficient when its members do what they think is best rather than doing what the group wants them to do.

20. A group is more productive when its members follow their own interests and concerns.

Item Key: Items 1-10, 12, and 18-20 reverse scored such that larger scores indicate greater collectivism.

APPENDIX C

HMX Scales for Alpha, Bravo, and Charlie

HMX - Alpha

It is important for us to understand how well you think you worked with each of your teammates. Using the scale below, indicate how much you **Agree** with the following statements. Mark your responses on the scantron sheet.

1. **Strongly Disagree**
2. **Disagree**
3. **Slightly Disagree**
4. **Neither Agree Nor Disagree**
5. **Slightly Agree**
6. **Agree**
7. **Strongly Agree**

1. Bravo and I would probably get along well as teammates.
2. Bravo would say that he/she and I would probably get along well as teammates.
3. I could probably count on Bravo to help me out.
4. Bravo would say that he/she could count on me to help out.
5. Bravo's ability would probably make him/her an excellent teammate.
6. Bravo would say that my ability would probably make me an excellent teammate.

7. I would probably like Bravo as a coworker.

8. Bravo would say that he/she would probably like me as a coworker.

9. I could probably trust Bravo to stick by me if things got difficult.

10. Bravo would say that he/she could probably trust me to stick by him/her if things got difficult.

11. Bravo would probably do an excellent job on this team.

12. Bravo would say that I would probably do an excellent job on this team.

13 Bravo and I would probably have a good working relationship.

14. Bravo would say that he/she and I would probably have a good working relationship.

15. Charlie and I would probably get along well as teammates.

16. Charlie would say that he/she and I would probably get along well as teammates.

17. I could probably count on Charlie to help me out.

18. Charlie would say that he/she could count on me to help out.

19. Charlie's ability would probably make him/her an excellent teammate.

20. Charlie would say that my ability would probably make me an excellent teammate.

21. I would probably like Charlie as a coworker.

22. Charlie would say that he/she would probably like me as a coworker.

23. I could probably trust Charlie to stick by me if things got difficult.

24. Charlie would say that he/she could probably trust me to stick by him/her if things got difficult.

25. Charlie would probably do an excellent job on this team.

26. Charlie would say that I would probably do an excellent job on this team.

27 Charlie and I would probably have a good working relationship.

28. Charlie would say that he/she and I would probably have a good working relationship.

Item Key: 21, 22, 27, 28 = affect; 23, 24, 29, 30 = Trust; 25, 26, 31, 32 = Contribution to the relationship; 33, 34 = Global assessment of relationship quality; All items scored positively.

It is important for us to understand how well you think you would probably work with each of your teammates. Using the scale below, indicate how much you **Agree** with the following statements. Mark your responses on the scantron sheet.

1. **Strongly Disagree**
2. **Disagree**
3. **Slightly Disagree**
4. **Neither Agree Nor Disagree**
5. **Slightly Agree**
6. **Agree**
7. **Strongly Agree**

1. Alpha and I would probably get along well as teammates.
2. Alpha would say that he/she and I would probably get along well as teammates.
3. I could probably count on Alpha to help me out.
4. Alpha would say that he/she could count on me to help out.
5. Alpha's ability would probably make him/her an excellent teammate.
6. Alpha would say that my ability would probably make me an excellent teammate.
7. I would probably like Alpha as a coworker.
8. Alpha would say that he/she would probably like me as a coworker.
9. I could probably trust Alpha to stick by me if things got difficult.
10. Alpha would say that he/she could probably trust me to stick by him/her if things got difficult.

11. Alpha would probably do an excellent job on this team.

12. Alpha would say that I would probably do an excellent job on this team.

13 Alpha and I would probably have a good working relationship.

14. Alpha would say that he/she and I would probably have a good working relationship.

15. Charlie and I would probably get along well as teammates.

16. Charlie would say that he/she and I would probably get along well as teammates.

17. I could probably count on Charlie to help me out.

18. Charlie would say that he/she could count on me to help out.

19. Charlie's ability would probably make him/her an excellent teammate.

20. Charlie would say that my ability would probably make me an excellent teammate.

21. I would probably like Charlie as a coworker.

22. Charlie would say that he/she would probably like me as a coworker.

23. I could probably trust Charlie to stick by me if things got difficult.

24. Charlie would say that he/she could probably trust me to stick by him/her if things got difficult.

25. Charlie would probably do an excellent job on this team.

26. Charlie would say that I would probably do an excellent job on this team.

27 Charlie and I would probably have a good working relationship.

28. Charlie would say that he/she and I would probably have a good working relationship.

HMX - Charlie

It is important for us to understand how well you think you would probably work with each of your teammates. Using the scale below, indicate how much you **Agree** with the following statements. Mark your responses on the scantron sheet.

1. **Strongly Disagree**
2. **Disagree**
3. **Slightly Disagree**
4. **Neither Agree Nor Disagree**
5. **Slightly Agree**
6. **Agree**
7. **Strongly Agree**

1. Alpha and I would probably get along well as teammates.
2. Alpha would say that he/she and I would probably get along well as teammates.
3. I could probably count on Alpha to help me out.
4. Alpha would say that he/she could count on me to help out.
5. Alpha's ability would probably make him/her an excellent teammate.
6. Alpha would say that my ability would probably make me an excellent teammate.
7. I would probably like Alpha as a coworker.
8. Alpha would say that he/she would probably like me as a coworker.
9. I could probably trust Alpha to stick by me if things got difficult.
10. Alpha would say that he/she could probably trust me to stick by him/her if things got difficult.

11. Alpha would probably do an excellent job on this team.

12. Alpha would say that I would probably do an excellent job on this team.

13 Alpha and I would probably have a good working relationship.

14. Alpha would say that he/she and I would probably have a good working relationship.

15. Bravo and I would probably get along well as teammates.

16. Bravo would say that he/she and I would probably get along well as teammates.

17. I could probably count on Bravo to help me out.

18. Bravo would say that he/she could count on me to help out.

19. Bravo's ability would probably make him/her an excellent teammate.

20. Bravo would say that my ability would probably make me an excellent teammate.

21. I would probably like Bravo as a coworker.

22. Bravo would say that he/she would probably like me as a coworker.

23. I could probably trust Bravo to stick by me if things got difficult.

24. Bravo would say that he/she could probably trust me to stick by him/her if things got difficult.

25. Bravo would probably do an excellent job on this team.

26. Bravo would say that I would probably do an excellent job on this team.

27 Bravo and I would probably have a good working relationship.

28. Bravo would say that he/she and I would probably have a good working relationship.

APPENDIX D

Coordination Cognitions Scales for Alpha and Bravo

Coordination Cognitions - Alpha

Using the scale to the right, indicate how much you **Agree** with the following statements. Mark your responses on the scantron sheet.

1. **Strongly Disagree**
2. **Disagree**
3. **Slightly Disagree**
4. **Neither Agree Nor Disagree**
5. **Slightly Agree**
6. **Agree**
7. **Strongly Agree**

1. I should provide the Missile Lock cue to Bravo before making my decision.
2. Bravo would agree that I should provide the Missile Lock cue to him/her before making my decision.
3. Bravo should provide the Initial Bearing cue to me before making his/her decision.
4. Bravo would agree that he/she should provide the Initial Bearing cue to me before making his/her decision.
5. I should provide the Missile Lock cue to Bravo after making my decision.

6. Bravo would agree that I should provide the Missile Lock cue to him/her after making my decision.

7. Bravo should provide the Initial Bearing cue to me after making his/her decision.

8. Bravo would agree that he/she should provide the Initial Bearing cue to me after making his/her decision.

9. The order in which Bravo and I make decisions and pass information to each other is not important.

10. Bravo would agree that the order in which we make decisions and pass information to each other is not important.

11. Neither Bravo nor myself need to coordinate our actions with Charlie.

12. Bravo would agree that neither of us need to coordinate our actions with Charlie.

13. It is important for Bravo and myself to work on the same target together.

14. Bravo would agree that it is important for us to work on the same target together.

15. If I get behind, it is important for Bravo to wait for me to catch up.

16. Bravo would agree that if I get behind, it is important that he/she waits for me to catch up.

17. If Bravo gets behind, it is important for me to wait for him/her to catch up.

18. Bravo would agree that if he/she gets behind, it is important for me to wait for him/her to catch up.

Coordination Cognitions - Bravo

Using the scale below, indicate how much you **Agree** with the following statements. Mark your responses on the scantron sheet.

1. **Strongly Disagree**
2. **Disagree**
3. **Slightly Disagree**
4. **Neither Agree Nor Disagree**
5. **Slightly Agree**
6. **Agree**
7. **Strongly Agree**

1. Alpha should provide the Missile Lock cue to me before making his/her decision.
2. Alpha would agree that he/she should provide the Missile Lock cue to me before making his/her decision.
3. I should provide the Initial Bearing cue to Alpha before making the Intent decision.
4. Alpha would agree that I should provide the Initial Bearing cue to him/her before making the Intent decision.
5. Alpha should provide the Missile Lock cue to me after making his/her decision.
6. Alpha would agree that he/she should provide the Missile Lock cue to me after making his/her decision.
7. I should provide the Initial Bearing cue to Alpha after making the Intent decision.
8. Alpha would agree that I should provide the Initial Bearing cue to him/her after making the Intent decision.

9. The order in which Alpha and I make decisions and pass information to each other is not important.

10. Alpha would agree that the order in which we make decisions and pass information to each other is not important.

11. Neither Alpha nor myself need to coordinate our actions with Charlie.

12. Alpha would agree that neither of us need to coordinate our actions with Charlie.

13. It is important for Alpha and myself to work on the same target together.

14. Alpha would agree that it is important for us to work on the same target together.

15. If Alpha gets behind, it is important for me to wait for him/her to catch up.

16. Alpha would agree that if he/she gets behind, it is important for me to wait for him/her to catch up.

17. If I get behind, it is important for Alpha to wait for me to catch up.

18. Alpha would agree that if I get behind, it is important for him/her to wait for me to catch up.

APPENDIX E

Satisfaction Scale for All Team Members

Using the scale below, indicate how **Satisfied** you are with each aspect of your experience here today. Mark your responses on the scantron sheet.

How **Satisfied** are you with...

1. **Extremely Dissatisfied**
2. **Dissatisfied**
3. **Slightly Dissatisfied**
4. **Neutral**
5. **Slightly Satisfied**
6. **Satisfied**
7. **Extremely Satisfied**

1. Your job on this team.
2. The time you had to do your job.
3. The amount of teamwork required to do your job.
4. The amount of support and help your teammates gave you during the simulation.
5. The way your team worked together during the simulation.
6. The way you were treated by your teammates during the simulation.
7. Your teammates overall.
8. The way you performed during the simulation.

9. The way your team performed during the simulation.
10. Your overall experience on this team.

APPENDIX F

Communication Effectiveness Scales for Alpha and Bravo

Communication Effectiveness - Alpha

Using the scale below, indicate how much you **Agree** with the following statements. Mark your responses on the scantron sheet.

1. **Strongly Disagree**
2. **Disagree**
3. **Slightly Disagree**
4. **Neither Agree Nor Disagree**
5. **Slightly Agree**
6. **Agree**
7. **Strongly Agree**

1. Bravo gave me the information I needed to do my job.
2. Instead of giving me the information I needed when I needed it, Bravo was more concerned with getting his/her own job done.
3. Bravo gave me the information I needed at the right time.
4. Bravo was too slow getting me the information I needed.
5. The way Bravo communicated with me helped me perform better.

6. I could have made decisions about Targets faster if Bravo had passed information to me faster.

7. Bravo communicated information to me very effectively.

8. Bravo should have done a better job getting me the information I needed when I needed it.

# APPENDIX G

## Consent Form

The study in which you are about to participate investigates your performance of the Tactical Action Game (TAG). TAG is a computer simulated, radar tracking task in which you and two teammates will measure the attributes of targets which appear on your radar screen and decide what action should be taken for each target. Your computer screen and communications will be recorded. You will also be asked to answer questionnaires to help us understand your task performance.

The experiment will consist of one session of approximately two hours length. No possible risks or discomforts are anticipated as a result of this study. Your responses will be confidential and will remain anonymous in any report of the research findings. At the end of your involvement, you will be given feedback detailing the purpose of this research.

Your participation is completely voluntary. You are free to discontinue the study at any time, for any reason, without penalty. You are free to ask any questions you might have about this study at any time. You may ask questions about the outcome of the study at any time by contacting Earl Nason through the Department of Psychology or by telephone at 353-2880.

Consent. I have been advised of my rights as a human subject in the above-described study. With my signature below, I acknowledge my authorization for participation. I further acknowledge that the investigator and his/her associates have satisfactorily answered any questions I have at this point and will make themselves available, as needed, during the course of the study. I understand that I am free to withdraw this consent and discontinue participation in this study at any time without penalty.

# APPENDIX H

## Debriefing Form

The study in which you just participated was designed to examine the effects of the relationships between team members on individual and team performance and the processes which take place in teams.

During this study, you were told your scores on the tests you completed were typical. This information was false. Your scores were not compared to anyone else's scores. If you were told anything about anyone else's scores, this information was also false. Your scores were, and will continue to be, confidential. You also operated a radar simulation which required you to work as a team to gather information about objects on you screen and take actions based on that information. Following the simulation, you answered questions about the simulation and your team.

We will use the information gathered during the study to link the decisions you made during the simulation to your beliefs about teamwork, your teammates, and individual and team performance. One of the issues we will investigate is the effects of the relationships among team members on how they communicate and perform.

Most of the questions you answered have no right or wrong answers and have no significance other than to help us understand your attitudes and beliefs about teams. As described above, we may have attempted to alter some of your beliefs about your scores or member's scores. If you received any such information, please remember it was false and has no significance outside this study.

**Please do not tell anyone who may become a subject in this experiment anything about the study.** The confidentiality of the design of this study is critical to its success. Even a simple comment about the false information we provided you could ruin

this research, so please do not reveal anything about the study to anyone who might become a subject in this experiment in the future.

If you have any questions about this study or would like to receive a copy of the results when they are complete, please notify the investigator now. If you have any questions about the study or would like to receive the results when they are complete, please call the investigator listed below. Finally, thank you for participating in this study. We tried to make it as interesting for you as possible and are open to suggestions. So, if you think we can improve this study in any way, please feel free to talk to us now or in the future.

Investigator

Earl Nason, 353-2880

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